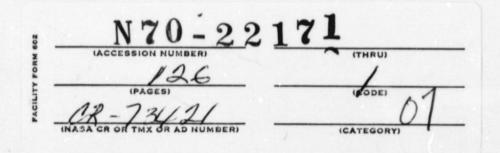# General Disclaimer

One or more of the Following Statements may affect this Document

- This document has been reproduced from the best copy furnished by the organizational source. It is being released in the interest of making available as much information as possible.

- This document may contain data, which exceeds the sheet parameters. It was furnished in this condition by the organizational source and is the best copy available.

- This document may contain tone-on-tone or color graphs, charts and/or pictures, which have been reproduced in black and white.

- This document is paginated as submitted by the original source.

- Portions of this document are not fully legible due to the historical nature of some of the material. However, it is the best reproduction available from the original submission.

FINAL REPORT

INFORMATION TRANSFER SYSTEMS REQUIREMENT STUDY

by W. C. Sedlacek, R. E. Leonard, and J. E. Burtt

Prepared by

LOCKHEED MISSILES & SPACE COMPANY

Sunnyvale, California

for NASA Mission Analysis Division, Office of Advanced Research and Technology

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION • MOFFET FIELD, CALIFORNIA

MARCH 1970

FINAL REPORT

INFORMATION TRANSFER SYSTEMS REQUIREMENT STUDY

Distribution of this report is provided in the interest of information
exchange. Responsibility for the contents resides
in the author or organization that prepared it.

1 March 1970

by

W. C. Sedlacek, R. E. Leonard, and J. E. Burtt

for NASA Mission Analysis Division, Office of Advanced Research and Technology

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

ABSTRACT

The study was a pioneering effort encompassing the entire communications field; therefore, the study approach was of broad scope, with a minimum of detail analysis. On this basis, organization of the study material was of primary importance. This was accomplished by following a study logic which recognizes that future in-depth studies will be made and the overall objective was to lay a foundation for such studies. To initiate this study, it was necessary first to generate a list of potential demands for the transfer of information. This list involved all conceivable demands for service, and it was compiled by literature search, imagination, and futuristic predictions. Since one of the objectives of the study was to predict the most promising demands, it was necessary to assess the economic growth potential for each of these demands. Lack of economic data on individual demands made it imperative to relate the demand to an economic grouping representative of the demand, such as space program expenditures for space telecommunications, and hospital admissions for patient records. From expert predictions of the future, correlation with forcing functions (such as the GNP and population), by regression analyses, and by the use of computer prediction techniques, trend curves were generated for these demand indicators. Relating these curves to the specific demand permitted the selection of the most promising demands from an economic standpoint.

To more fully understand each demand category it was necessary to study the category in a general way and document important characteristics by providing a profile on demand categories. With these profiles, and the economic projections of the demand indicators, it was possible to determine the functional requirements on a broad operational basis. Overall appraisal of the relative importance of the demand was possible at this time; therefore, a preliminary selection of demands was made and they were cataloged. The first benefit ranking was then made on the selected demands. The basis for this ranking was the relative benefit to the U.S. each demand would provide if a service was implemented to satisfy it.

To further screen these demands it was necessary to consider the ease of implementing a service to satisfy the demand. This was accomplished by making a second evaluation on the basis of service implementation. Then, by combining these two evaluations for the purpose of obtaining a more comprehensive ranking it was possible to make a final selection of demands and demand categories. The applicability of the most promising demands to service implementation was the final step in the study.

CONTENTS

TABLES

ILLUSTRATIONS

SUMMARY AND INTRODUCTION

The transfer of information today is in a self-perpetuating situation in which the demands for service and the development of the capability to satisfy these demands are stimulating each other, generating increasingly higher levels of communication traffic loads, new technology, and operational capabilities we did not realize existed. Conventional means for meeting these demands for information transfer services are now being saturated, as evidenced by tieups in our transportation systems – particularly in air traffic control and ground traffic control at major airports – by the recent restricted hours of trading on the New York Stock Exchange, and by the inadequacy of the New York telephone service in the metropolitan area.

The projection of this situation into the next decade, and the availability of new technology advancements that can overcome these saturated communication problems, suggests that studies be made of demands for transfer of information, their requirements, and an overall appraisal of the situation.

In March, 1969, a contract was awarded to Lockheed Missiles & Space Company by the NASA Mission Analysis Division of the Office of Advanced Research and Technology, Moffett Field, California, to study the information transfer requirements for the time period 1970 to 1985. The study objective was broad in concept, since the study was directed toward the market potential for information transfer, but it was not to be considered a "technology assessment" or "benefit analysis." It was a pioneering effort, since it attempted to encompass the entire telecommunications area rather than to deal with specific areas, as has been done in the past by other organizations. It is to be considered a first iteration of future NASA studies that would become progressively more detailed; thus, it is in no sense a final evaluation of rigid position.

The study does provide a look at those demands for information transfer services that are now considered impossible because of the need for technology advancements, such as increasing the broadcast spectrum by using frequencies above 10 GHz. If this kind of capacity can be made available at reasonable rates, it will provide the basis for the all purpose "home communication center," often mentioned in the popular press. The study also considers the demands for additional services due to inadequacies of conventional services, and it provides NASA with planning data that identify future critical telecommunication areas which might warrant intensified NASA activity. A study that attempts to provide such an overall perspective of the entire telecommunication field necessarily must operate under certain ground rules which are consistent with the allotted study time and budget considerations. Therefore, it was necessary to limit the study in the following ways:

- Consider only those demands involving long-haul information transfer service. While this restraint reduces the magnitude of the study, it does not affect results. Short-haul communications service is already receiving a great deal of attention; thus its exclusion does not affect the value of the study results for NASA's purposes.
- Maintain an objective overview and perspective in contrast to a study in depth. Any bias towards any one type of telecommunication or service to satisfy the demand for information transfer would defeat the purpose of the study.

- Consider all information transfer demands that could be found by literature research or by discussion with experts, whether for government (nondefense), business, or private purposes and regardless of geographic location, providing their use benefits the United States.
- Consider only the 1970 and 1985 time periods since these two time periods cover the needs for NASA short and long term planning.
- Consider the change, with time, in the volume of transfer of information to be more important than specific values. This constraint was imposed since exact quantitative data was difficult to determine (particularly for the newer, more rapidly developing information fields) yet contributed very little to the overall study objective of determining trends for information transfer services.
- Consider detailed analysis of functions and parameters of advanced information transfer satellites as outside the scope of this study. This was done to separate the requirements analyses from the design concept phase, the effect being to maintain objectivity in the establishment of requirements.

The term "transfer of information," as used in this study, includes all functions of communications as well as data transfer. "All functions of communications" pertains to electronic communication at a distance. In terms of facilities, it includes telegraph, telephone, radio, television, data transmission, picture transmission — anything in which information is transmitted in the form of an electric signal. It excludes physical distribution of books or face-to-face conversations.

The "demand" for the transfer of information was considered throughout the study as a quantitative measure of the market potential of a particular need. The objective of the study then was to identify these demands, their relative potential payoff and their functional requirements.

With this objective, the following basic issues were confronted by the study:

- What are the magnitudes of the functional requirements for the future information transfer demands?
- Which demands, if satisfied by a service, are most beneficial to the nation?
- Which demands are most amenable to satellite service and government sponsorship?
- Which demands, on the basis of the study, should be further studied by NASA?
- How will the demands for transfer of information change with time?
- What are the commonality factors between demands for transfer of information?

2

The answers to the preceding questions constitute the principal output of the study; a preliminary cataloging of the most promising information transfer demands and a categorization of their functional requirements are presented in the following sections.

Figure 1 shows the study logic which was followed to organize the study material. The figure highlights the sequential flow of study data, the reiterations, and the results of the five tasks comprising the study.

```
┌─────────────────────────────────────────────────────────────┐
│       GENERATE LIST OF INFORMATION TRANSFER DEMANDS           │
└─────────────────────────────────────────────────────────────┘

┌──────────────────────────┐      ┌──────────────────────────────┐
│  PREPARE DEMAND PROFILES  │      │ PROJECT DEMAND ECONOMIC TRENDS │
└──────────────────────────┘      └──────────────────────────────┘

┌─────────────────────────────────────────────────────────────┐
│             DETERMINE FUNCTIONAL REQUIREMENTS                 │
└─────────────────────────────────────────────────────────────┘

┌─────────────────────────────────────────────────────────────┐
│        MAKE PRELIMINARY SELECTION OF DEMANDS & CATALOG        │
└─────────────────────────────────────────────────────────────┘

┌─────────────────────────────────────────────────────────────┐
│             MAKE FIRST RANKING BENEFIT ANALYSES              │
└─────────────────────────────────────────────────────────────┘

┌─────────────────────────────────────────────────────────────┐
│     MAKE SECOND RANKING SERVICE IMPLEMENTATION ANALYSES       │
└─────────────────────────────────────────────────────────────┘

┌─────────────────────────────────────────────────────────────┐
│       MAKE FINAL SELECTION OF MOST PROMISING DEMANDS          │
└─────────────────────────────────────────────────────────────┘

┌─────────────────────────────────────────────────────────────┐
│       MAKE STUDY OF APPLICABILITY OF SELECTED DEMANDS         │
│                 TO DISTRIBUTION NETWORKS                      │
└─────────────────────────────────────────────────────────────┘
```

Figure 1 Study Logic

DEMAND IDENTIFICATION AND CATALOGING

Background

Task I of the study included the generation of a list of all conceivable demands for transfer of information. The rationale for compiling the list of relevant demands, screening the list for feasibility, and relating the demands to individual classes of users is described in Chapter 6 of Ref. 1.

Criteria

Generation of the demand list was formulated on the basis of the following criteria:

- The demand must be beneficial to the United States
- A demand will be listed regardless of:
  - a. Cost
  - b. Degree of benefit
  - c. Political constraints
  - d. Feasibility

- A demand will be considered only at a system level, as compared to component levels
- The means for satisfying the demand will not be a consideration

These criteria contributed to negating prejudgments which would eliminate potentially valuable demands.

Constraints

In order to make the list of demands meaningful and directly relevant to the study, the following initial constraints were imposed:

- Short hauls for the transfer of information were not considered an acceptable demand (i.e. under 50 miles)
- Military demands were not considered
- Implementation of a service to satisfy the demand must be possible within the foreseeable future

Methodology

The methodology used in formulating the demand list included a search of Lockheed's Technical Information Center, NASA DIALOG data retrieval system, periodicals, and technical papers. The search centered on literature, technical data, and periodicals dealing with communications, telemetry, economic trends, data processing, automation, broadcast, navigation, computers and the green section of the telephone book. Specialists in the areas of business, hospital systems, criminal justice, and data retrieval and processing were consulted for recommendations and the existence of possible future demands. Because of the magnitude of the list of demands, the constant revision of the list, and the need for cataloging the list in several ways, it was programmed for storage in a computer. As each demand was generated it was assigned four indices: (1) Numeric, (2) Category, (3) Group, and (4) User.

A numerical indicator was assigned each demand title as it was added to the list, thus simplifying the location and identification of a particular demand title. Category numbers were assigned to demand categories — formulated by grouping demands that have commonality of operational requirements. Thirty-two demand categories were selected as representing all of the 255 demand titles initially listed. The categorization of these demands was considered in many different ways, such as by terminal data handling, services to be provided, and by national industry names (Ref. 2). After a thorough consideration of all these possibilities, the following 32 categories were considered as most representative of all the various areas of demands for information transfer.

INFORMATION TRANSFER DEMAND CATEGORIES

1. Space Programs Data Relay
2. Weather Data Relay
3. Oceanographic Data Relay
4. Earth Sciences Data Relay
5. Aircraft Data Handling
6. Marine Data Handling
7. Rescue Data Handling
8. Ground Traffic Data Handling
9. Statusing of Goods Data
10. Computer Data Handling
11. Point-to-Point Telecommunications
12. Teleconferencing Data
13. News and Broadcast Distribution
14. Electronic Publishing
15. Language Translation
16. Commercial Broadcast
17. Domestic Cultural Programming
18. International Cultural Programming
19. Educational Broadcasts
20. Library Data Handling

21. Welfare Data Handling	27. Data Securities Exchange
22. Health & Medical Data Transfer	28. Civil Defense Warning & Commu
23. Law Enforcement Data Transfer	Communications
24. Electronic Mail Transfer	29. Amateur Radio Broadcast
25. Government Auditing Data Transfer	30. Religious Exchange
26. Banking & Financial Data Transfer	31. Judicial Proceedings Broadcasts
	32. Time Signals Broadcasts

Initially, it was deemed necessary to derive a grouping classification that would be broader and more gross than the category breakdown and consequently would be easier to handle. The following "groupings" were therefore generated.

The alphabetic code placed to the far left of each demand serial number designates the grouping which the demand falls within. The coding of the groups follows:

B	Broadcast and Mass Media	M	Mail
C	Special Communications	N	Traffic and Navigation
E	Education	O	Space Programs
F	Finance and Banking	P	Law Enforcement (Police)
G	Government Services	Q	Inventory (Quantization)
H	Health and Medical	T	Telephone and Telegraph
I	Science Information	W	Welfare and Social Security
L	Library	X	Special Government, Foreign Aid

The type of user was also a point of interest during the study, therefore, the demand title list was coded in accordance with the type of user. This coding is as follows:

A	Aircraft	H	Home and Personal
B	Business	M	Marine
E	Schools and Students	S	Scientific and Professional
G	Government Agencies	T	Terrestrial Mobile Users

Cataloging

From the previous discussion it may be seen that the demand title list was cataloged in four different ways and therefore could be drawn out of the computer in these four catalogs. For purposes of simplification the following master demand title list (shown as it was drawn from the computer) is catalogued on a numerical basis. Referring to this list, there is one column that has not already been discussed and this is the "disposition code." One of the goals of the study was to formulate a master demand title list that would not only document the titles of each demand but also show the disposition of each demand. This was accomplished by coding those demands in the following way.

C Signifies the demand title was combined within another demand title. The number to the left of the letter identifies the demand it was combined with. The main reason for combining was because of redundancy in titles.

D Signifies the demand was dropped from further consideration. Dropping of a demand was judged on the basis of constraints and criteria established initially

DT Signifies the item is a "Demand Indicator." (Definition of this item will be found in the section on "Demand Trend Analysis.")

FF Signifies the item is a "Forcing Function." (Definition of this item will be found in the section on "Demand Trend Analysis.")

The interrelationships of demand trend indicators and forcing functions was so great that in some cases they were designated under both headings.

A blank space within the disposition column indicated this demand was involved in all evaluations during the study.

NUMERIC SORT

GROUP INDEX	NUMERIC INDEX	USER INDEX		CATEGORIES	DISPOSITION CODE	
P	001	G	LAW ENFORCEMENT, IDENTIFICATION	23		
P	002	G	LAW ENFORCEMENT, RECORDS	23		
P	003	G	LAW ENFORCEMENT, INTERROGATION		042	C
P	004	G	LAW ENFORCEMENT, CRIME INVESTIGATION AND ANALYSIS		002	C
P	005	G	LAW ENFORCEMENT, RAPID REAL TIME POSITIVE IDENTIFICATION		001	C
E	006	N	EDUCATIONAL, PRE-SCHOOL	19		
E	007	E	EDUCATIONAL, GRADE SCHOOL	19		
E	008	E	EDUCATIONAL, HIGH SCHOOL	19		
G	009	E	EDUCATIONAL, COLLEGE	19		
E	010	E	EDUCATIONAL, POST GRADUATE	19		
E	011	G	EDUCATIONAL, ADULT, NON-GRADUATE	19		
X	012	E	EDUCATIONAL, DEVELOPING NATIONS	19		
E	013	G	EDUCATIONAL, CRIMINAL REHABILITATION	19		
E	014	G	EDUCATIONAL, POLICE	19		
E	015	E	EDUCATIONAL, PRE SCHOOL-PROGRAM HEAD START		006	C
E	016	E	EDUCATIONAL, AILING AT HOME	19		
E	017	E	EDUCATIONAL, RURAL COMMUNITIES	19		
E	018	E	EDUCATIONAL, DISADVANTAGED	19		
E	019	E	EDUCATIONAL, NORMAL, GIFTED			D
E	020	S	EDUCATIONAL, COLLEGE-SCIENTIFIC, MEDICAL		010	C
E	021	S	EDUCATIONAL, BUSINESS, LEGAL, ARTS		010	C
E	022	S	EDUCATIONAL, POST GRADUATE		010	C
E	023	G	EDUCATIONAL, WELFARE	19		
E	024	G	EDUCATIONAL, UNEMPLOYED, FOREIGN BORN		023	C
E	025	G	EDUCATIONAL, CRIMINAL REHABILITATION		013	C
E	026	G	EDUCATIONAL, POLICE EDUCATION AND INSTRUCTION		014	C
M	027	H	MAIL-AIR, FIRST CLASS	24		
H	028	G	MEDICAL, BLOOD, EYE, ORGAN, SERUM BANKS	22		
H	029	G	MEDICAL, HOSPITAL-PATIENTS-ADMINISTRATIVE	22		
H	030	G	MEDICAL, HEALTH RECORDS (GOVRNMMENT)	22		
H	031	G	MEDICAL, SMOG MONITORING		030	C
H	032	H	MEDICAL, DIAGNOSTIC AND TREATMENT, ON-LINE-INFORMATION	22		
H	033	G	MEDICAL, HEALTH, EDUCATION AND WELFARE NETWORK		011	C
H	034	G	MEDICAL, SMOG STUDIES AND CONTROL		030	C
H	035	H	MEDICAL, MEDICAL AND HEALTH NETWORK			D
F	036	H	BANKING, CHECKS, CERTIFICATION-VERIFICATION-PROCESSING	26		
F	037	H	BANKING, CREDIT CARDS		039	C
F	038	H	BANKING, IDENTIFICATIONS		040	C
F	039	B	BANKING, ACCOUNTING, ON-LINE	26		
F	040	B	BANKING, ON-LINE IDENTIFICATION	26		
F	041	B	BANKING, PROCESSES	26		
T	042	H	GROUND TO GROUND TELE-COMMUNICATION, VOICE	11		
T	043	H	GOUND TO GROUND TELE-COMMUNICATION, VIDEO PHONE	11		
T	044	H	GROUND TO GROUND TELE-COMMUNICATION, LONG DISTANCE TELEPHONE		042	C
B	045	B	NEWS, PRINTING AND PUBLICATION	13		
B	046	H	NEWS, DAILY PAPERS		045	C
B	047	B	NEWS, LAYOUT		048	C
B	048	H	NEWS, FACSIMILE PRODUCTIONS	14		
N	050	A	AIRCRAFT COMMUNICATION, COMMERCIAL	5		
N	051	A	AIRCRAFT COMMUNICATION, PRIVATE	5		
N	052	A	AIRCRAFT COMUNICATION, FOR AIRLINE PASSENGERS		050	C
N	053	A	AIRCRAFT, AIR AND SEA RESCUE, EMERGENCY COMMUNICATION	5		
N	054	T	MOBILE GROUND COMMUNICATION	8		
N	055	T	MOBILE GROUND COMMUNICATION, TRUCKS		054	C
N	056	T	MOBILE GROUND COMMUNICATION, BUSES		054	C
N	057	T	MOBILE GROUND COMMUNICATION, TRAINS		054	C
L	058	H	LIBRARY, PUBLIC	20		
L	060	S	LIBRARY, SPECIAL	20		
L	061	E	LIBRARY, COLLEGES AND UNIVERSITIES	20		
L	062	E	LIBRARY, SCHOOLS	20		
L	063	S	LIBRARY, PATENTS	20		
L	064	G	LIBRARY, SCIENTIFIC DATA NETWORK FOR NASA, BUREAU OF STDS, ETC,		060	C
L	065	B	LIBRARY, BUSINESS AND UNIVERISTY SCIENTIFIC COMPUTER NETWORK		060	C
L	066	G	LIBRARY, PATENT SERVICE-SEARCH, RETRIEVAL, DISPLAY STATUS		063	C
W	067	H	WELFARE, UNEMPLOYMENT	21		
W	068	H	WELFARE, SOCIAL SECURITY	21		
W	069	H	WELFARE, HOUSING	21		
W	070	G	WELFARE, URBAN LAND UTILIZATION	21		
W	071	G	WELFARE, URBAN LAND UTILIZATION, DEVELOPMENT PLANNING		070	C
W	072	G	WELFARE, HEALTH, EDUCATION AND WELFARE NETWORK			D
W	073	G	WELFARE, GENERAL ADULT EDUCATION, WELFARE, UNEMPLOYED		023	C
C	074	B	SECURITIES EXCHANGE, TRANSACTIONS	27		
C	075	H	SECURITIES EXCHANGE, QUOTATIONS	27		

F	076	H	SECURITIES EXCHANGE, STOCK BOND AND COMMODITY QUOTATIONS	075	C
F	077	B	SECURITIES EXCHANGE, SECURITIES CONTROL NETWORK, ISS. OF SEC.	074	C
!	078	G	WEATHER, BALLOON	2	
!	079	G	WEATHER, BUOYS	2	
!	080	G	WEATHER, SATELLITE	2	
!	081	G	WEATHER, STATIONS	2	
!	082	G	WEATHER, SATELLITE CONTROL AND DATA RELAY	080	C
!	083	G	WEATHER, OCEANOGRAPHY DATA RELAY FROM FLOATING STATIONS	2	
!	084	G	WEATHER, FORECASTING CLIMATE STUDIES	2	
N	085	G	WEATHER, MONITORING AIR MASSES BY BALLOON TRANSPONDERS	078	C
N	086	A	AIRCRAFT, ENROUTE AIR TRAFFIC POSITION, COMMERCIAL	5	
N	087	A	AIRCRAFT, ENROUTE AIR TRAFFIC POSITION, PRIVATE	5	
N	088	A	AIRCRAFT, ENROUTE AIR TRAFFIC COLLISION AVOIDANCE SYSTEM	5	
N	089	A	AIRCRAFT, ENROUTE AIR TRAFFIC CONTROL	086	C
N	090	M	MARINE COMMUNICATION, COMMERCIAL	6	
N	091	M	MARINE COMMUNICATION, PRIVATE	6	
N	092	G	MARINE COMMUNICATION, GOVERNMENT	6	
N	093	G	COMMUNICATION (SHIPS), PRECISION NAVIG. COMM. SYS FOR AIR + SH.	095	C
N	094	M	COMMUNICATION (SHIPS) SHIP TO SHORE COMMUNICATIONS LINK	090	C
N	095	M	MARINE, SHIP POSITION, COMMERCIAL	6	
N	096	M	MARINE, SHIP POSITION, PRIVATE	6	
N	097	G	MARINE, SHIP POSITION, GOVERNMENT	6	
N	098	G	MARINE, COLLISION AVOIDANCE SYSTEM	6	
F	099	G	INTERNAL REVENUE, PERSONAL	25	
F	100	G	INTERNAL REVENUE, CORPORATION	25	
F	101	F	INTERNAL REVENUE, FEDERAL EXCISE TAX	25	
F	102	H	INTERNAL REVENUE, DUTIES	25	
F	103	G	INTERNAL REVENUE, STATE	25	
F	104	G	INTERNAL REVENUE, TREASURY AND GENERAL ACCOUNTING	25	
!	105	G	OCEANOGRAPHICAL FISHING	3	
!	106	G	OCEANOGRAPHICAL SHIP ROUTING	3	
!	107	G	OCEANOGRAPHICAL, SEA STATE	3	
!	108	G	OCEANOGRAPHICAL, RESOURCES	3	
!	109	G	OCEANOGRAPHICAL, WAVE STUDIES, SEA STATE, TIDAL WAVES	107	C
B	110	H	ENTERTAINMENT, TELEVISION	16	
B	111	H	ENTERTAINMENT, RADIO	16	
N	112	B	SELECTED ENTERTAINMENT, COMMERCIAL RADIO AND TELEVISION		D
P	113	A	AIRCRAFT, ENROUTE AIRCRAFT PERFORMANCE	5	
T	114	H	MEETING, UNITED NATIONS	12	
T	115	H	MEETING, CONVENTIONS	12	
T	116	S	MEETING, PRIVATE	042	C
W	117	B	MEETINGS, BUSINESS	12	
X	118	G	MEETINGS, HOT LINE	12	
A	119	G	MEETINGS, POLITICAL ACTIONS, UNITED NATIONS, CONVENTIONS	115	C
B	120	H	MEETINGS, LEGISLATIVE DEBATES, PROCEEDINGS, INVESTIGATIONS	12	
B	121	H	MEETINGS, UNITED NATIONS SESSIONS BROADCASTS-GLOBAL	115	C
B	122	H	MEETINGS, DELEGATE PRESENTATIONS TO GOVERNMENTS AND PEOPLE	12	
G	123	B	MEETINGS, STOCKHOLDER	12	
N	124	H	MEETINGS, UNION	12	
X	125	G	MEETINGS, 'HOT LINES' TO FOREIGN GOVERNMENTS	118	C
G	126	G	MEETINGS, HEADS OF STATE, 3-D U.N. MEETINGS AND PRESENTATIONS	115	C
T	127	S	MEETINGS, THREE DIMENSIONAL COLOR VIDEO CONFERENCE SERVICE	115	C
T	128	S	MEETINGS, PRIVATE, BUSINESS, UNION, ETC.	115	C
T	129	S	MEETINGS, SCIENTIFIC AND TECHNICAL SOCIETY	12	
Q	130	A	SCHEDULING AND STATUS AIRLINE	5	
Q	131	M	SCHEDULING AND STATUS, SHIPS	6	
Q	132	T	SCHEDULING AND STATUS, TRAINS	8	
Q	133	B	SCHEDULING AND STATUS, HOTELS	139	C
Q	134	T	SCHEDULING AND STATUS, BUSES	8	
Q	135	B	INVENTORY CONTROL	139	C
Q	136	B	INVENTORY CONTROL	139	C
Q	137	B	INVENTORY CONTROL, STATUSING, EXCHANGE OF DATA, INTERROGATIONS	139	C
Q	138	B	INVENTORY CONTROL, AUDITING + CONTROL NETWORK-INVENTORIES, ETC	139	C
Q	139	B	INVENTORY CONTROL, CONTROL, MONITORING AND STATUSING OF GOODS	9	
Q	140	T	FREIGHT MOVEMENT, TRUCK	139	C
Q	141	T	FREIGHT MOVEMENT, TRAIN	139	C
Q	142	M	FREIGHT MOVEMENT, SHIP	139	C
Q	143	A	FREIGHT MOVEMENT AIR	139	C
T	144	B	FREIGHT MOVEMENT, CONTROL MONITORING AND STATUSING OF GOODS	139	C
!	145	H	AUTOMATED LANGUAGE TRANSLATION VOICE	15	
!	146	B	AGRICULTURAL	15	
!	147	G	AGRICULTURAL, CROP SURVEILLANCE-SOIL CONSERVATION	4	
!	148	G	GEOLOGICAL/TOPOGRAPHY DATA	4	
!	149	S	GEOLOGICAL, SURVEY AND TOPOGRAPHY	148	C
!	150	B	GEOLOGICAL, PRECISION SURVEYING OVER LARGE DISTANCES	4	
!	151	S	HYDROLOGY	152	C
!	152	G	HYDROLOGY, STREAM CONDITIONS, EROSION, POLLUTION CONTROL	4	
!	153	G	CIVIL DEFENSE AND EMERGENCY WARNING	28	
!	154	G	CIVIL DEFENSE AND EMERGENCY COMMUNICATIONS	28	

No.	Code	Title		
155	H	CIVIL DEFENSE AND EMERGENCY BROADCASTS	153	C
156	S	TIME SIGNALS	157	C
157	G	TIME SIGNALS FOR SYNCHRONIZATION	32	
158	H	CULTURAL PROGRAM, DOMESTIC	161	C
159	G	CULTURAL PROGRAM, INTERNATIONAL	18	
160	G	CULTURAL PROGRAM, CULTURAL EXCHANGE	161	C
161	G	CULTURAL PROGRAM, MUSEUMS, GALLERIES, HISTORICAL EVENTS	17	
162	B	MIGRATORY FISH	3	
163	G	MIGRATORY, ANIMALS	4	
164	G	MIGRATORY, BIRDS	4	
165	G	MIGRATORY, FISH AND GAME LOCATION AND MANAGEMENT	162	C
166	H	COURT PROCEEDINGS, CRIMINAL	168	C
167	S	COURT PROCEEDINGS, CIVIL	168	C
168	G	COURT PROCEEDINGS, JUDICIAL ACTIONS REVIEW	31	
169	B	COMPUTER, COMPUTATIONAL	10	
170	S	COMPUTER, REAL TIME	169	C
171	B	COMPUTER, LOGISTICS	169	C
172	G	SPACE PROGRAM, MANNED ORBITAL	175	C
173	G	SPACE PROGRAMS, EARTH RESOURCES SATELLITE	1	
174	G	SPACE PROGRAMS, UNMANNED	179	C
175	G	SPACE PROGRAMS, MANNED ORBIT SUPPORT	1	
176	G	SPACE PROGRAMS, ASTRONOMY	1	
177	G	SPACE PROGRAMS, DEEP SPACE	1	
178	G	SPACE PROGRAMS, COMPUTER FACILITY	1	
179	G	SPACE PROGRAMS, SATELLITE CONTROL	1	
180	G	SPACE PROGRAMS, ASCENT TRACKING, DATA RELAY AND CONTROL		D
181	G	SPACE PROGRAMS, ASSEMBLY ON ORBIT	1	
182	G	SPACE PROGRAMS, PERFORMANCE AND TESTING	1	
183	G	SPACE PROGRAMS, SPACE NAVIGATION		D
184	G	SPACE PROGRAMS, TRACKING OBJECTS		D
185	G	SPACE PROGRAMS, ICEBERG MONITORING	173	C
186	G	SPACE PROGRAMS, GLACIER AND SNOW CONDITIONS	173	C
187	T	GROUND TRAFFIC CONTROL, CITY	8	
188	T	GROUND TRAFFIC CONTROL, HIGHWAY	8	
189	T	GROUND TRAFFIC CONTROL, POSITION AND DIRECTION, FOR LOW SPEED	187	C
190		FORESTRY SERVICES, SURVEY, MANAGEMENT	190	C
192		DEPARTMENT OF DEFENSE, COMPUTER NETWORK		D
192		DEPARTMENT OF DEFENSE, COMPUTER NETWORK		D
193		DIPLOMATIC AND TRADE DATA AND COMMUNICATION NETWORK TO EMBASSIE		D
194		SERVICE COMMUNICATION		D
195		SECURE COMMUNICATION		D
196		ELECTRONIC RECORD TRANSMITTAL		D
197		THREE DIMENSIONAL COLOR VIDEO CONFERENCE SERVICE		D
198		SOUTH AMERICAN AID		D
199		INDIAN AID		D
200		AFRICAN AID		D
202		PRINTING AND PUBLISHING		DT
204		CRIME RATE PER 100 POPULATION	FF	DT
205		HIGH SCHOOL GRADUATES		DT
206		UTILITY POWER PRODUCTION	FF	DT
208		POLICE PROTECTION	FF	DT
209		HEALTH AND MEDICAL ADMISSIONS TO HOSPITALS		DT
210		TV AD EXPENDITURES		DT
211		AIR MAIL DOMESTIC		DT
212		U.S. SCHOOL POPULATION		DT
214		U.S. SCHOOL POPULATION	FF	DT
215		COLLEGE DEGREES CONFERRED	FF	DT
216		AIR MAIL INTERNATIONAL		DT
217		MARITIME COMM -SEA AIR RESCUE		DT
218		COMPUTING INDUSTRY MACHINE SALES	FF	DT
219		NUMBER OF TELEPHONES		DT
220		INTERSTATE LONG LINES EQUIVALENT VOICE CKTS.		DT
221		TOTAL AD EXPENDITURES		DT
223		LONG DISTANCE CALLS PER DAY		DT
224		INTERSTATE LONG LINES EQUIVALENT VOICE CKTS, FOR TV-FACS, DATA		DT
225		RADIO AD REVENUES		DT
226		INDEX OF HOMOCIDE	FF	DT
227	G	LAW ENFORCEMENT, PROBATION MONITORING	23	
228	H	LAW ENFORCEMENT, RELEASE ON RECOGNIZANCE	23	
229	H	EDUCATION, HOME FOR AILING	016	C
230	H	MEDICAL, HOME DIAGNOSIS AND MONITORING		D
231	H	ELECTRONIC TRAVEL, SHOWS, CONVENTIONS, ETC.	17	
232	H	LIBRARY HOME EXTENSION	20	
233	S	LANGUAGE TRANSLATION GRAPHICS	15	

Q	234	B	RESERVATION SERVICE - ACCOMODATION PRESENTATION	133	C
L	235	B	COMMERCIAL SERVICES INFORMATION RETRIEVAL	060	C
F	236	E	SCHEDULING AND STATUSING OF TRUCKS	8	
			GROSS NATIONAL PRODUCT		FF
	251		POPULATION		FF
	252		UTILITY POWER PRODUCTION	DT	FF
	253		INDEX OF HOMOCIDE	DT	FF
	254		U.S.SCHOOL POPULATION	DT	FF
	255		UTILITY REVENUES		FF
	256		U.S.TRUNK AIRLINE REVENUES	DT	FF
	257		INTERSTATE TELEPHONE CIRCUITS TOTAL		FF
	258		INTERSTATE TELEPHONE CIRCUITS SPEC.		FF
	259		COLLEGE GRADUATES	DT	FF
	260		PUBLIC EDUCATION EXPENSES		FF
	261		HOSPITAL ADMISSIONS		FF
	262		COMPUTER SALES	DT	FF
	263		PERSONS TWENTY ONE YEARS OF AGE		FF
	264		PIECES OF MAIL HANDLED		FF
	265		TELEPHONE TOLL CALL REVENUE		FF
	266		EXPENDITURES FOR POLICE PROTECTION	DT	FF
	267		CRIME RATE PER 100 POPULATION	DT	FF
	268		PUBLISHING REVENUES		FF
	269		R AND D EXPENDITURES		FF
	276		REVENUE PASSENGER MILES FLOWN		DT
	277		AIRCRAFT ACCIDENTS		DT
	278		U.S. MERCHANT MARINE VESSELS		DT
	279		TOTAL CIVIL AIRCRAFT (U.S.)		DT
	280		BUSINESS AND PERSONAL AIRCRAFT SALES		DT
	281		FREE WORLD AIRLINE		DT
	282		CARGO REVENUE TON MILES FLOWN		DT
	283		GOVERNMENTAL EXPENDITURES FOR NATURAL RESOURCES		DT
	284		GOVERNMENTAL EXPENDITURES FOR PUBLIC WELFARE		DT
	285		EXPENDITURES FOR LIBRARIES BY COLLEGES		DT
	287		NO. OF SHAREHOLDERS IN U.S.		DT
	288		U.S.TRUNK AIRLINE REVENUES	FF	DT
	289		U.S. INTERCITY FREIGHT TRAFFIC		DT
	290		INCOME TAX RETURNS FILED		DT
	291		INDIVIDUAL INCOME TAX RETURNS		DT
	292		COMMERCIAL BROADCAST STATIONS AUTHORIZED		DT
	293		UTILITY RADIO STATIONS		DT
	294		EXPENDITURES FOR SPACE SCIENCE APPLICATIONS		DT
	295		U.S. EXPENDITURES FOR SPACE PROGRAMS		DT
	296		COLLEGE GRADUATES PER YEAR		DT
	298		PATIENTS IN MENTAL HOSPITALS		DT
B	299	H	AMATEUR RADIO	29	
F	300	E	RELIGIOUS PROGRAMS	30	
I	301	G	EARTHQUAKE MONITORING	4	
H	302	S	MENTAL THERAPY GROUPS	12	
B	303	H	TV AND RADIO PROGRAM DISTRIBUTION	13	
G	304	H	CENTRALIZED PERSONNEL RECORDS	068	C
Z	305	B	CORPORATION RECORDS		D
Y	306	B	REMOTE SALES	043	C
I	307	B	MARKET ANALYSIS	139	C
D	308	S	AUTOMATED DESIGN AND DRAFTING	10	
	309	S	AUTOMATED LEGAL ADVICE	10	
T	310	H	FAMILY PURCHASING AND HOME MANAGEMENT ADVICE	10	
N	311	H	RESERVATION AND SCHEDULE	10	
P	312	S	AUTOMATED LEGAL SEARCH LIBRARIES	060	C
C	313	B	AUTOMATED SECURITY SYSTEMS	074	C
G	314	G	SPECIAL GOVERNMENT TECHNICAL INFORMATION CENTER	060	C
	315	G	AUTOMATED RESOURCES MANAGEMENT CENTER	139	C
A	316	B	MONETARY VALUE TRANSFER AND ACCOUNTING SYSTEM	041	C
T	317	H	HOME INFORMATION CENTER	10	
U	319	S	HEALTH EDUCATION	023	C
G	320	G	DEPARTMENT OF AGRICULTURE EDUCATION PROGRAMS	010	C
G	321	H	RULINGS AND REGULATIONS	25	
X	322	G	PROGRAMS FOR AMERICANS OVERSEES	159	C

ACQUISITION OF DATA, CONTACTS, REVIEWS AND INTERNAL DATA ORGANIZATION

Background

In order to analyze the whole spectrum of information transfer areas to a limited yet relatively uniform depth, a significant effort was expended in the research, acquisition, review, organization, and application of considerable amounts of data in numerous subject areas. The acquisition techniques which were utilized included library searches, contacts with users and specialists, formal reviews, and exchange of preliminary data. The information acquired from these techniques was organized within the study organization for daily reference and compiled in internal documentation to support the many and various analyses which are subsequently discussed. The result of this work loses its identity in discussions of the analyses and their results. It, therefore, is appropriate to briefly summarize in this section this activity, which took place throughout the seven and one-half month period of study.

Search and Acquisition of Written Source Data

A composite of search techniques was utilized to bring into a central location that information which had to be integrated for the specialized study purposes. Early computer searches using "Dialog" identified many NASA and other technical reports. Lockheed's library and search personnel were utilized for texts, periodicals, and reference sources. The library facilities of Stanford University, Stanford Research Institite, and NASA-Ames Research Center were also generously offered to and used by the study team. In many cases where contacts were made, reports were also made available. During other contacts, titles and sources of reports were obtained and subsequently acquired. Direct acquisition of literature was made by subscription to FCC Reports and numerous acquisitions from the Superintendent of Documents, and by the Lockheed Library in response to the requests of this study team.

Contacts and Consultations

To supplement written material and to bridge the gaps found in available written material in several instances, contacts were made in many of the "user" areas with specialists in their fields. Specialists in analytical areas were also contacted for guidance in methods and analysis techniques utilized. It is safe to say hundreds of discussions were completed during the study. The following list of key personnel contacted represents the variety of consultations made in local and regional areas, as well as throughout the U.S.

	Agency/Company	Principle Contact	Study Area
1.	Stanford Univ.-School of Engineering	Dr. B. Lusignian (T)	Functional Requirements
2.	Lockheed Information Sciences	Dr. R.K. Summit (C)	Library Mission
3.	Lockheed Tech. Information Center	Dr. W.A. Kozumplik (C)	Library Mission
4.	Lockheed Corp-Chief Economist	Dr. H.R. Biederman (T)	Economic Outlook 1970-80
5.	Lockheed-Hospital Information Systems	Mr. J.P. Finnigan (C)	Medical & Health Mission

(T) Telecon
(C) Consultation

6.	Lockheed-Medical Information Systems	Mr. W. D. Fuller (C)	Medical & Health Mission
7.	Lockheed-Govt. Information Systems	Mr. K. J. Prim (C)	Law Enforcement Mission
8.	Lockheed-Scientific Computing	Dr. H. P. Hartkemeier (C)	Forcing Function Indicators
9.	NASA Ames-Chief Librarian	Mr. Merle Boylan (T)	Library Mission
10.	NASA Ames	Dr. Paul Swan (C)	Asst. Dir. of Space Miss.
11.	Arcata International	Mr. Lillie (T)	Stock Transaction Mission
12.	National Institute of Health	Dr. R. M. Davis (C)	Medical & Health Mission
13.	National Institute of Health	Dr. R. P. Christenson (C)	Medical & Health Mission
14.	National Institute of Health	Mr. M. Z. Thornton (C)	Medical & Health Mission
15.	National Institute of Health	Mr. D. G. Moriarty (C)	Medical & Health Mission
16.	Sea Land Co.	Mr. McLean (T)	Goods in Transit Mission
17.	Bunker Ramo	Mr. J. Brennan (T)	Stock Market Mission
18.	Massachusetts Institute of Technology	Mr. E. G. Frankel (T)	Goods in Transit Mission
19.	Scantlin Elec. Inc.	Mr. Levine (T)	Stock Market Mission
20.	U. S. Dept of Agriculture	Dr. R. H. Miller (T)	Crop Surveillance Mission
21.	Sea Land Corp.	Mr. John Lynch (T)	Transportation Mission
22.	Bunker Ramo Corp.	Mr. J. Brennan (T)	Securities Exch. Mission
23.	U. S. Coast Guard	Capt. Handy (T)	Search & Rescue Mission
24.	Children's TV Workshop, New York	Dr. Robertson (T)	Education of Handicapped Mission
25.	Pacific Far East Lines	Mr. J. L. Edwards (C)	Shipping Mission
26.	COMSAT Corp.	Mr. R. D. Briskman (C)	Education TV Mission
27.	Federal Communications Commission	Mr. Geo. Smith (C)	Emergency Broadcast Mission
28.	Dept. of Agriculture	Dr. F. Miller (C)	Earth Resources Mission
29.	TV Children's Workshop, New York	Dr. Davidson (C)	Pre-School Education Mission
30.	Metroprocessing, N.Y.	Mr. L. Davidson (C)	Electronic Newspaper & Computer Telecommunications
31.	Bunker-Ramo Corp.	Mr. J. Brennan (C)	Securities Exch. Mission
32.	Sea Land Corp.	Mr. John Lynch (C)	Transportation Mission
33.	National Bureau of Standards	Mr. George Kamas (C)	Time Signals Mission
34.	Univ. of Colorado	Prof. F. Caro (C)	Urban Development
35.	Bureau of Reclamation	Dr. Cohen (C)	Meteorology Mission
36.	Consultant	Dr. K. Borchardt (C)	Demand Trend Analysis
37.	National Institute of Health	Mr. M. Z. Thornton (C)	Medical & Health Mission
38.	Civil Defense, Region 7 Hq	Mr. Roy Post (C)	Civil Defense Mission

NEW REGION IX HQ

39. o Public Info. Office	Mr. Ned Burman (C)	NEW Missions
40. o Dental & Health Ctr	Dr. Winston Frenzel	Post Grad Educa. Mission
41. Office of Education Regional Commissioner	Dr. Paul Lawrence (C)	Education and Library Mission
42. Office of Education Regional Commissioner	Mr. C. Kent Bennion (C)	Education and Library Mission
43. Office of Education Regional Commissioner	Mr. John Thorsted (C)	Education and Library Mission
44. Office of Education Regional Commissioner	Mrs. Helen Luce (C)	Education and Library Mission
45. Office of Education Regional Commissioner	Miss Katherine Alderfer (C)	Education and Library Mission
46. Soc. Security Admin. Regional Commissioner	Mr. Gilbert Khachadourian (C)	Social Security Mission
47. Soc. Security Admin. Regional Commissioner	Mr. Steven Stratton (C)	Employment Records
48. Soc. Security Admin. Regional Commissioner	Mrs. Natalie Rapp (C)	Employment Records
49. Soc. Security Admin. Regional Commissioner	Miss Christine Cannon (C)	Medical Health Insurance

The exchange of information led to many other potential contacts suggested for sources of further depth of information or for further views on future concepts. Some of these suggested contacts were made. Many, however, were not possible to follow-up on due to the limited time available for any specialized area during this phase of the study.

Contact Through Reviews and Exchange of Data

The terms of the contract established the requirement for periodic reviews of data compiled and intermediate results obtained from the study. Largely through the interest shown by many organizations within NASA and its contractors, opportunities existed to present methodology, concepts, compiled data, and preliminary study results to key personnel associated with information transfer fields. The following list of participants in reviews for this study is shown for various milestone reviews during the study period. These are in addition to the Lockheed Study Team personnel and the NASA Study Monitor, Mr. E. M. Van Vleck

KICK-OFF MEETING — APRIL 14, 1969

Attendees:

NASA Headquarters
Dr. W. A. Radius

NASA-Ames Research Center
L. Roberts
H. Hornby
D. H. Dennis
E. W Gomersall

13

2ND MONTH REVIEW MEETING – JUNE 3, 1969

Attendee:

NASA-Manned Space Flight Center
Mr. C. J. Kovitz

MID-TERM REVIEW MEETING – JULY 17, 1969

Attendees:

NASA Manned Spacecraft Center
Houston, Texas
C. J. Kovitz

NASA Headquarters
Washington, D. C.
Dr. A. Radius
W. H. Allen
Don Rogers
P. F. Barritt

NASA Goddard Space Flight Center
Greenbelt, Maryland
E. J. Habib, Code 520

Jet Propulsion Laboratory
Pasadena, California
G. E. Gilchriest, Telecommunications
N. Servi   W. Ruhland

NASA Langley Research Center
Dr. Ford Kalin

General Dynamics/Convair
San Diego, California
Pat Bergin
John Fager
Dr. R. Norbutas

Hughes
H. L. Weinberger

Stanford Research Institute
R. Hough

NASA Mission Analysis Division
Moffett Field, California
K. Nishioka – Special Projects
L. Roberts – Director, MAD
D. H. Dennis, Deputy Director, MAD
R. C. Savin, Tech. Assistant to Dir.
F. G. Casal, Propulsion Systems
P. R. Swan, Space Missions
B. L. Swenson, Space Missions
E. L. Tindle, Space Missions
J. L. Anders, Space Missions
K. F. Sinclair, Space Missions
J. L. Anderson, Space Missions
J. M. Deerwester, Space Missions
R. H. Petersen, Aero. Missions
T. J. Gregory, Aero. Missions
T. L. Galloway, Aero. Missions

FINAL REVIEW MEETING – DECEMBER 2, 1969

Attendees:

Hughes Space Systems
El Segundo, California
Lawrence Norwood
Fred W. Field
Fred Fruhling
L/P. Reiche
L. M. Gould

General Dynamics/Convair
San Diego, California
John Fager
P. A. Bergin
E. T. Lipscomb

United States Air Force
SAMSO, Los Angeles
Captain William Whitmire

Aerospace Corporation
El Segundo, California
Robert G. Clabaugh

TRW System, Inc.
Redondo Beach, California
Ken H. Renshaw
Joe Freitag

Rand Corp., Santa Monica, Calif.
Paul Jordan
John Hult

COMSAT Laboratories,
Clarksburg, Maryland
Joachim Kaiser

ESEA Title Ill, Monticello, Fla.
Florine Way

Federal Aviation Agency
San Francisco, California
Donald E. Pearson
Lynn L. Hink

Interspace Communications, Inc.
Pacific Palisades, California
H. L. Weinberger

Stanford Univ., Stanford, Calif
A. Horley

Washington University
St. Louis, Missouri
J. R DuMolin

North American Rockwell, Space Div.
Downey, California
K. A. Ehricke

General Electric Co.
Philadelphia, Pa.
R. J. Sierzenski
G. L. McBride

Systems Applications, Inc.
Beverly Hills, Calif.
Richard N. Lane
George P. Mandanis

Earthsatellite Corp.
Washington, D.C.
Allan H. Muir

NASA Headquarters
Washington, D.C.
Dr. Walter Radius
J. T. McClanahan

Bellcom, Inc.
Washington, D.C.
John J. Hibbert

NASA Goddard Space Flight Center
Greenbelt, Maryland
Sam Gubin

NASA Mission Analysis Division, OART
Moffett Field, California
D. H. Dennis – Acting Director
R. C. Savin – Technical Assistant
H. M. Drake – Asst. Dir. Aeronautical
  Missions
R. H. Petersen
George Kenyon
Harold Hornby – Asst. Dir. Spec.
  Projects
E. W. Gomersall
L. R. Alton
B. L. Swenson, Space Missions
J. L. Anderson
J. M. Deerwester
S. M. Norman

During or subsequent to these reviews, many of the attendees were furnished presentation material and a variety of preliminary reports covering areas of significant results of study available at that particular time. A feedback through NASA was realized in this process, which proved of value to the subsequent study phases.

During the study, a paper entitled "Requirements for Integrated Information Nets (Year-1990)" was prepared by Lockheed and presented to two professional societies. First, the paper was given to SAE's Aeronautical, Space Engineering, and Manufacturing meeting in Los Angeles on October 9, 1969. Later, on October 25, 1969,

it was updated and presented to the American Astronautical Society meeting on "Space Technology and Earth Problems," at Las Cruces, New Mexico.

Internal Data Organization Methods

In order to make available basic acquired data of significance to several areas of the study, a central source file was organized internally and maintained throughout the study. The organization was broken into two major groups; one group organized by Mission Category contained all material relative to the categories and their associated missions. The second major group organized data by activity, such as Demand Trends, Statistical Tables, Economics, Technology, Methodology References, etc. The composite simple arrangement proved adequate to support the many analyses defined in subsequent sections.

Documentation of intermediate results in internal reports was a technique followed to compile data into a form which proved to be useful to assist in the completion of subsequent analyses, and also provided a product which documented decisions reached, rationale, and those values selected among many possible choices. Examples of these documents included: Master Mission Lists, Functional Requirements Methodology, Preliminary Demand Trend Analyses, Computerized Trend Projections, and Preliminary Benefit and Service Implementation Analysis.

Demand Profiles

One additional major type of internal documentation was created early in the study to integrate basic material for a given category of missions. This document was identified as a "Mission Profile." The evolution of the design of the format for the profile was fairly involved. Originally conceived as 2-3 pages for each demand category, the document grew to an average of over twenty pages and encompassed the entire demand category. This evolution was natural as the research of mission information got underway. In this period, several factors were found to influence the form and content of the profile. These were:

(1) Pertinent information was not uniformly available on all individual demands. Conversely, some demand information was redundant with others.
(2) It made sense to research similar groups of demands and document pertinent information at one time rather than to jump from category to another.
(3) It also made sense to complete the documentation of the demands of similar category with data complete enough to pass on to other study analyses with a minimum of additional research.

Consequently, profiles were prepared encompassing groups or categories of demands. The format for the profile evolved in a similar manner. An early look at the data required for the various analyses downstream in the study provided the fundamental contents. A list of contents for mission profiles is as follows:

- Introduction
- Concept description
- Substantiation
- Information description
- Distribution system
- Number of Users
- Location of Distribution Terminals
- Message spacing
- Response time
- Message duration
- Privacy
- Benefits
- Assumptions
- References

The introduction and concept description of the profile presented the general situation anticipated in the 1975-1985 time period and the "conceptual network" that was anticipated to accommodate the information transfer potential. Substantiation for this situation was based on such factors as Public Laws, national objectives, expert opinions, expenditure of funds in the area, and similar data. The form and content of information to be handled was identified and the means of distribution from source to users was sketched or described. Two-way information transfer was the rule rather than exception. Care was taken to identify the long haul portion of this distribution system. The number of users at the long haul terminals were defined. The locations of these user terminals in the U.S. or outside of the U.S. were discussed in general terms. The use rate in terms of numbers of messages per period of time was identified. Other message characteristics, such as response time, message duration, privacy, and reasons for the relative degree of speed, privacy, etc., were identified for the category of missions. Benefits anticipated in broad terms were explained whether they were financial, social, or scientific. Assumptions had to be made to give credibility to the hypothesized network of the future. These were listed along with references to important sources of data which gave professional or expert opinions dealing with the subject.

A major difficulty in completing each profile was locating the right data which would interface with other data required by the format. For example, the message was of little value if its relationship could not be determined to some measure of trend. Hospital messages could be tied to patients, which in turn were a matter covered by statistical data, for example. Literally hundreds of such decisions were made per profile to interrelate research data in order to:

- Postulate conceptual network for 1975 and 1985
- Utilize credible and available operating experience data
- Project future trends on a credible basis
- Relate statistical trends which are credible and available

These are but a few of the decisions made; another major decision, however, was to limit depth of detail when detail was found available, such as in the category of education.

During the study period, some 19 Mission Profiles were prepared. Their total pages exceeded 400. This data has not been included in this final report because of its volume and working material nature. The mission categories which were the subjects for the 19 profiles are shown in the list below:

- Space Program Data Relay
- Education Broadcasts
- Weather Data Relay
- Health & Medical Data Transfer Data
- Teleconferencing
- Welfare Data Handling
- Earth Sciences Data Relay
- Oceanographic Data Relay
- Civil Defense Warning & Communications

- Computer Data Handling
- Library Data Handling
- Law Enforcement Data Transfer
- Data Securities Exchange
- Banking & Financial Data Transfer
- Rescue Data Handling
- Pt to Pt Telecommunications
- Marine Data Handling
- Electronic Publishing

Through the organization of the data researched for study an effective means was found to apply significant data to the analyses leading to the results which were established as objectives for the study. This material, while still maintained in internal working form, is considered useful to form a foundation for further expansion of the study in areas designated by NASA.

DEMAND TREND ANALYSIS

Objective

The Demand Trend Analysis was made to provide trend indicator data and curves which define the probable future needs for information transfer through 1990. Trend indicators were derived from available historic data relevant to the basic needs of our society. Ideally, the trend indicators should be sufficiently basic to indicate not only past trends of the fulfillment of needs and demands for services; but also should provide a rational basis for predicting the possible future needs and demands for new and improved services.

This analysis encountered several basic factors which influenced the selection of basic time series data for the trend analysis and the cataloging and grouping of the trend data and curves. Two basic findings were recognized early in the study activity; they were as follows:

- Several identifiable trends usually influenced the individual information transfer "market potential" of a given demand.
- Many demands were influenced by the same or similar basic trend data, e.g., population growth, gross national product, research and development expenditures, etc.

The recognition of these factors prompted the analysis of demand categories rather than on an individual demand basis, and further prompted the development of broad economic trends which might be applied to several demands and/or to demand categories to provide applicable information. These economic trends used in this study were as follows:

Demand Trend Indicator – a measure of an economic area that can be projected from historical data to indicate trends of a specific demand.
Forcing Function – a basic economic factor that influences demand trend indicators

Background

The demand trend analysis methodology followed is shown in the block diagram (Figure 2) and the following description will be in accordance with this diagram. The final demand trend indicator curves and, data relevant to the future needs for information transfer, were developed by means of this methodology. The list of these Demand Trend Indicators and their related Forcing Functions, applicable to each of the thirty-two categories of demands, are shown in Table 1. Most of the curves and data in the list were produced with the aid of computer curve fitting and projection routines on a few curves were produced manually to cover special conditions such as an expanded time frame or multiple curves for the set of data points presented.

18

DEMAND CATEGORIES

BASIC TIME SERIES DATA: • FORCING FUNCTIONS • TRENDS OF DEMAND INDICATORS • NO. OF USERS • DATA RATE		

REGRESSION AND CORRELATION ANALYSIS

HISTORICAL TREND ANALYSIS

DEMAND TREND EVALUATION

DEMAND TREND PREDICTION

COMPUTERIZED ANALYSIS AND PROJECTION TECHNIQUES

DETAILED ANALYSES FOR FORECASTS

TREND INDICATOR CURVES
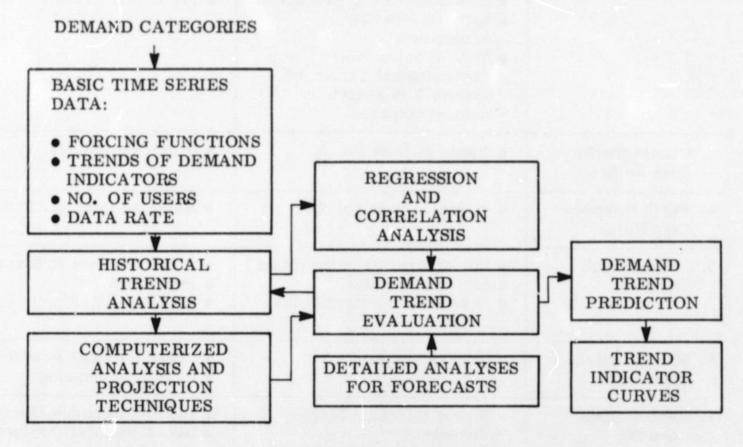
Figure 2 Demand Trend Analysis Methodology

Many authoritative sources of information were utilized in the preparation of the curves identified in Table 1, such as time series data, trend predictions, forecasts, from the U.S. Department of Commerce and the Ford Foundation. These provide a basis for the development of additional forecasts related to specific needs for long distance information transfer services. Statistical Abstracts of the United States published annually by the U.S. Department of Commerce, has been used as the source of time series data wherever possible.

Table 1

DEMAND TREND AND FORCING FUNCTION INDICATORS
FOR ITS DEMAND CATEGORIES

Demand Categories	Demand Trend Categories	Forcing Function
1. Space Programs Data Relay	• U.S. Space Budget • Space Development Budget Trends • Space Sciences Applications Expenditures • Number of Operational Spacecraft	• Gross National Product • Scientific Growth Rate • Research & Development Expenditures

Table 1 (Continued)

2. Weather Data	• Expenditures for Research • Expenditures for Resources • Expenditures for Agriculture • Nos. of Scientists • Technological Trends of Growth & Research in Natural Sciences	• National Goals & Policies • Population Growth
3. Oceanography Data Relay	• (Same as Item No. 2)	• (Same as Item No. 2)
4. Earth Sciences Data Relay	• (Same as Item no. 2)	• (Same as Item No. 2)
5. Aircraft Data Handling	• No. of aircraft in operation • Airline Revenues • Revenue Passenger Miles Flown	• Gross National Product • Population • Accident Rates
6. Marine Data Handling	• Nos. of vessels	• Gross National Product • Growth of shipping
7. Rescue Data Handling	• No. of Merchant Marine Vessels • Free World Airline Revenues • Service Air-Sea Rescue	• Policy to Provide Rescue • Gross National Product • No. of Emergencies on Open Sea
8. Ground Traffic Data Handling	• No. of Utility Radios • Accident Rates • U.S. Intercity Freight Shipments	• Gross National Product • Technological Growth
9. Statusing of Goods Data	• Freight Traffic • Cargo transported by Air, Water, Land • Aircraft • Ships	• Gross National Product
10. Computer Data Handling	• Computer Sales • Increases in Computer Utilization • Interstate Long Distance Equivalent Voice Ckts	• Growth of Computer Utilization • Capabilities and values of computers versus cost
11. Point to Point Tele-communications	• Interstate Tel. Circuits • Long Distance Calls • Toll Revenues • Number of Telephones	• Gross National Product • Education • Mobility of People
12. Teleconferencing	• Airline Revenues • Business Aircraft • Professional & Management Population	• Gross National Product • College Graduates • Population

Table 1 (Continued)

13. News & Broadcast	• TV Facility Ckts • Broadcast Revenues • No. of Broadcast Stations • Advertising Revenues • Newspaper Revenues	• Gross National Product • Population
14. Electronics Publishing	• Education Levels • Printing & Publishing • Total Adv. Expenditures	• Gross National Product • Population
15. Language Translation	• Free World Travel • World Communications	• Foreign Trade & Travel • Tourist Trade
16. Commercial Broadcast	• Broadcast Stations • TV Advertising Exp. • Radio Adv. Exp. • Total Adv. Exp.	• Gross National Product • Population
17. Domestic Cultural Programing	• Expenditures for Culture • Expenditures for Travel	• National Goals • Gross National Product • Expenditures for Education
18. International Cultural Programing	• (Same as Item No. 17)	• (Same as Item no. 17)
19. Education Broadcast	• Median Ed. Levels • Education Revenues • U.S. Student Population • College Degrees Conferred • High School Grad	• Gross National Product • Population • Increase of Automation
20. Library Data Handling	• Expenditures by Colleges for Libraries & Services • Growth of Documentation	• Gross National Product • Research & Development Expenditures
21. Welfare Data Handling	• Expenditures for Public Welfare • Number of Recipients	• Gross National Product • Population
22. Health and Medical Data Transfer	• Hospital Admissions • Medical Revenues	• Gross National Product • Population
23. Law Enforcement Data Transfer	• Crime Rate • Population Mobility • Police Expenditures	• Gross National Product • Available Technology • Population
24. Electronic Mail Transfer	• Pieces of Air Mail • Pieces of First Class Mail • Air Mail Intl	• Gross National Product • Population • Publishing Expenditures

Table 1 (Continued)

25. Government Audting Data Transfer	• Increasing Use of Computer Systems • Computer Sales • Income Tax Returns Filed	• Availability of Technology • Trend Toward Automation
26. Banking & Financial Data Transfer	• Retail Sales • Numbers of checks written • Population	• Gross National Product
27. Data Securities Exchange	• Nos. of Share Holders • Nos. of Transactions	• Gross National Product • Increasing Education Level of the Nation
28. Civil Defense Warning & Communications	• Civil Defense Expenditures	• National Policy
29. Amateur Radio Broadcast	• Number of Amateur Radio, Licenses & Radios	• Technological Growth • Education Level
30. Religious Exchange	• Religious Broadcasts • Growth of Religion • Yearly Contributions	• Technological Growth
31. Judicial Proceeding Broadcast	• News Coverage • Crime Rate • Trials Commenced	• Policy of open courts and public awareness
32. Time Signals Broadcast	• Expenditures for Research and Development • Time Signal Accuracy Increase	• National Policy • Established Service • Accuracy requirements

Basic Time Series Data

Historic time series data provide the foundation from which the trend forecasts are made, therefore, it was important that only well documented historic data be used. However, sometimes well documented data are not available for either the desired parameters or the desired time frames, and in these cases documented long term data which can be rationally related to indicate future needs and growth trends was used.

In order to predict future trends from 1969 to 1990, data over a similar or longer period in history is desirable. The time period from 1950 through the present was chosen as a standard reference period, because data from 1929 through 1945 are highly perturbed, due to the effect of the great depression in the thirties and World War II in the early forties. The period between the end of World War II and 1950 was a period of recovery from the efect of the depression and the war. Where a longer period of historic trend data is desired for analysis, data are taken from prior to 1929. Analysis of time series data usually required some consideration for variances due to changes in the means by which the original data were obtained. There is some question, for example, as to how much of the presently reported increase in crime is due to improved methods and effectiveness in detecting and reporting crime rather than an actual increase in criminality. However, historical time series data collected over a relatively short period, such as from 1950 to the present, was more consistent than earlier data.

Historical Trend Analysis

Analysis of long term historical data shows that the forcing functions, such as U.S. gross national product, population, and education, increase at fairly steady rates over long periods of time. The effects of the depression and World War II appear as only cyclic disturbances upon the consistent growth trends. The review of long term trends, as documented in Ref. 3, presents a history of national progress in automation, economic, and social improvement. For example, since 1850 there has been a trend of improving productivity per worker and reduction of hours worked per person. Such basic historic trends were related to this study, because information transfer over long distances by means of electronics is a form of continuing automation which improves productivity and provides social benefits.

Historic trends suggest that the nineteenth century was the age of power and the twentieth century is the age of information. Since about 1950 the world has seen a tremendous growth in the sciences dealing with information. The recent growth of computer and electronic capabilities has developed into a communications revolution paralleling the industrial revolution of the nineteenth century. Reference 4 documents the historic growth trends of computers and communications services and projects future trends and benefits to be expected from information transfer and computers.

The reasons for the growing importance of information transfer in our society are documented in Ref. 5. From 1900 to 1959, for example, the number of people in knowledge-producing occupations increased by 600 percent. From 1900 to 1959 the number of clerks increased by 1000 percent; consequently, the largest present application of electronic data processing is the handling of clerical and business functions. A large measure of the needs for information transfer is also reflected in the growth of sales revenues in the computer industry. The uses of computers and teleprocessing in government and business are growing at an exponential rate of approximately 70 percent per year.

Historic trends and future projections of information transfer needs by government agencies are forecast in Ref. 6, show an exponential growth in government Special Services Data and Dedicated Network, from nearly zero in 1950 to 140,000 circuits in 1990. These historic trends for information transfer are consistent with growth trends of industry and technology and growth forecasts made in Ref. 7. Add.tional long term historic trends of national growth and projections of needs to the year 2000 were used from Ref. 8.

The trend analysis used for this study is similar to the one used in Ref. 8. The reference and this study are both concerned with meeting the specific future needs of the national and needs for information transfer for a growing society are related to the basic material and energy resource needs for industrial progress.

Fulfillment of the needs for information transfer requires capital investment, the same as for the development of other resources. This was modeled in Ref. 8. Within the model, economic growth of segments is related to population, labor force, households, and gross national product. In a similar manner, needs for information transfer are related to growth in numbers of aircraft, computers, home users, schools, businesses, etc. Further discussion of the trend analysis details can be found in Appendix A.

Computerized Analysis and Projection Techniques

The computer analysis and projection techniques described here, and previously, served as an aid in determining historical trends and forecasting future trends. The computer was used to construct charts and curves which were useful for analysis. Three basic machine techniques were used - exponential smoothing for short term projection, parabolic curve fitting, and linear regression curve fitting. The parabolic curve fitting technique and the linear regression technique are described in Appendix A. The exponential smoothing for short term projection technique was performed to obtain data on the next two year forecasts. This technique took a smoothed average of five data points, projected one data point ahead, and then, using the projected data points plus four historic data points, projected a second data point ahead. A variable weighting of 0.88 is used for each successively older data point. The technique is considered good for projecting four years ahead. Trend analysis showed that these short term forecasts were in fair agreement with the long term projections. Figures 3 through 10 present the set of computer generated curves and tables representing the three basic machine techniques for the U.S. School population. Figure 7 is the final projected school population trend chart plus a trend curve of the national population shown for reference.

Regression and Correlation Analysis

Regression analysis was used in order to determine the degree of correlation between various indicators, not as a determinant of whether correlation existed. A very high correlation between indicators, of a need for information transfer to GNP provided an aid to trend forecasting; however, it must be recognized that a strong correlation between two economic parameters in the past is no proof that the correlation will certainly exist in the future. Correlation does not in itself prove interrelationship or interdependence. Correlation is of value where there is an established relationship between variables (see Ref. 9), or rational reasons can be established for long term relationships. As a tool, it was used with some reservations, as discussed in the following pages.

DEMAND ANALYSIS   214   INFORMATION TRANSFER STUDY DATA
U.S. SCHOOL POPULATION
K=   2   M=   5   ALPHA=   .88

(1) EXPONENTIAL SMOOTHING
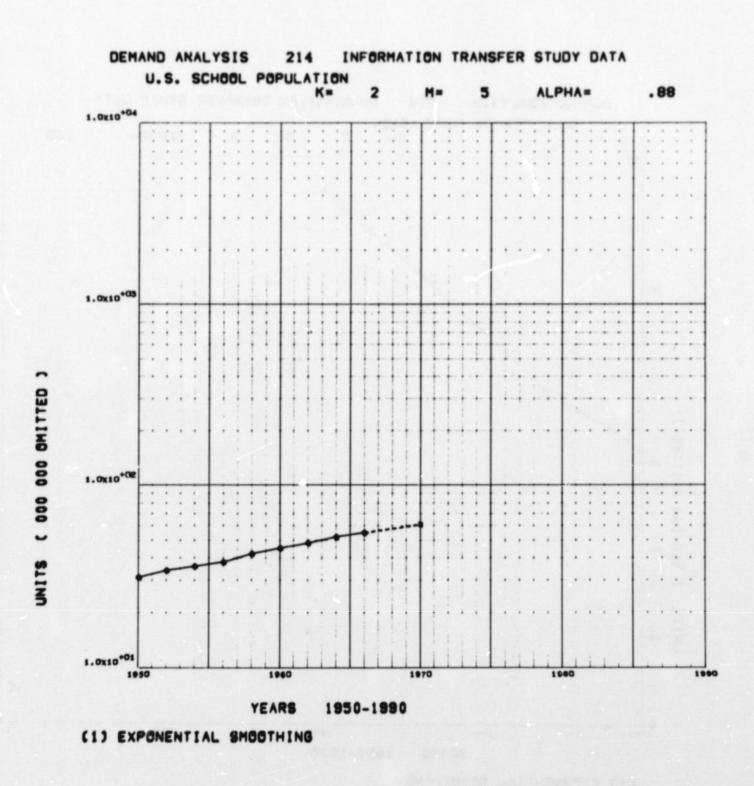
Figure 3 Exponential Smoothing–Semilog Plot

25
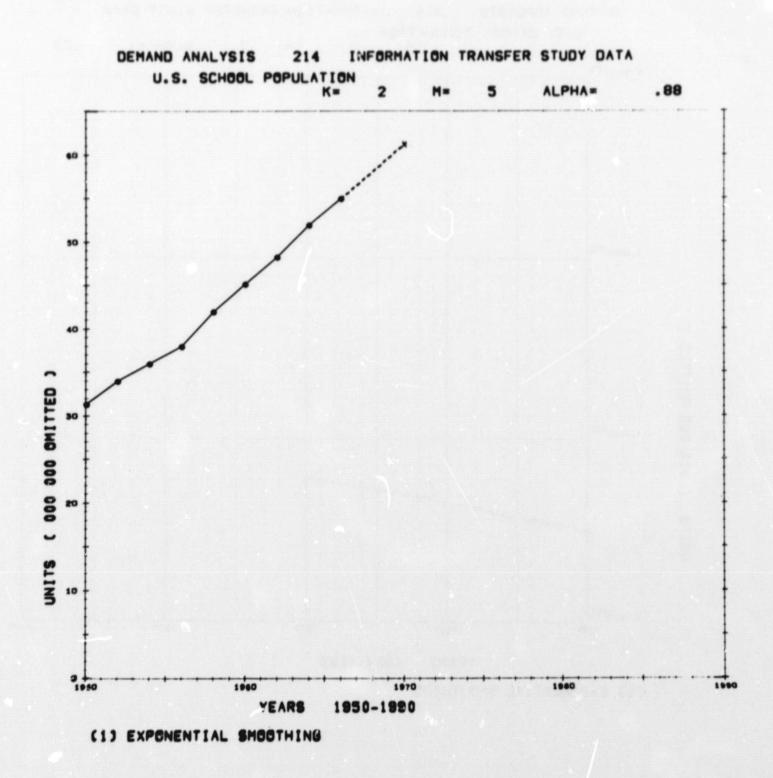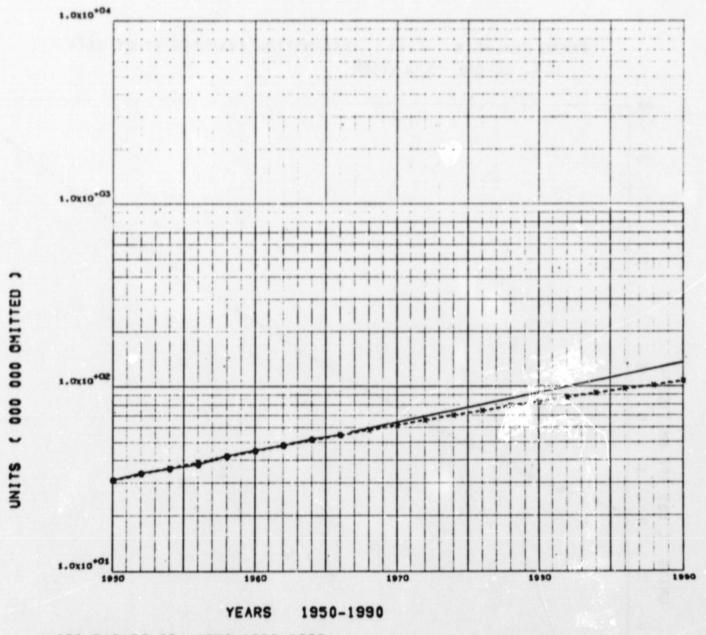
Figure 4 Exponential Smoothing-Linear Plot

26

DEMAND ANALYSIS   214   INFORMATION TRANSFER STUDY DATA
U.S. SCHOOL POPULATION

YEARS   1950-1990

(2) PARABOLIC, 1950,1958,1966
EXPONENTIAL ————

Figure 5 Parabolic Semilog Plot

27

DEMAND ANALYSIS   214   INFORMATION TRANSFER STUDY DATA
U.S. SCHOOL POPULATION

YEARS   1950-1990

(2) PARABOLIC, 1950,1958,1966

Figure 6 Parabolic Linear Plot

28

Figure 7 Regression, Linear Semilog Plot

DEMAND ANALYSIS   214   INFORMATION TRANSFER STUDY DATA
U.S. SCHOOL POPULATION

(3) REGRESSION, LINEAR
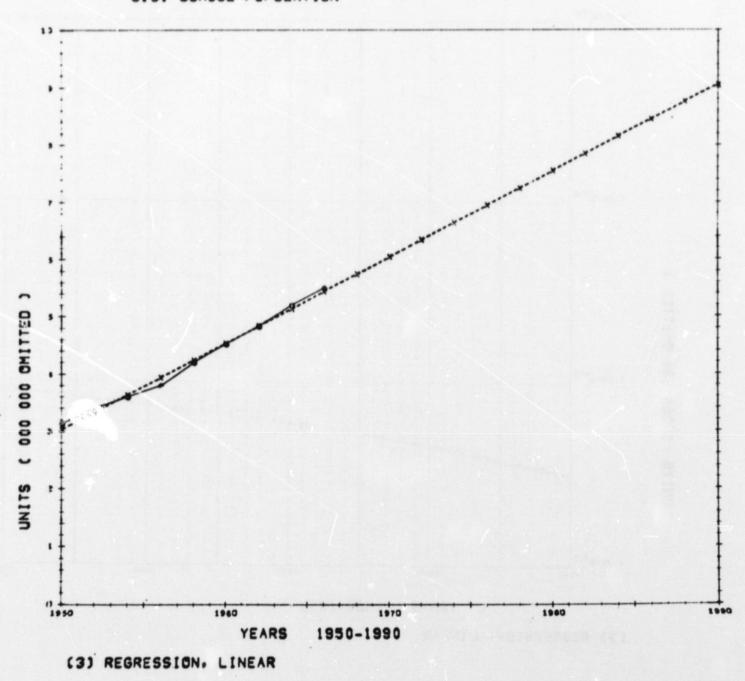
Figure 8 Regression, Linear-Linear Plot

DEMAND ANALYSIS   214   INFORMATION TRANSFER STUDY DATA
U.S. SCHOOL POPULATION
FORCING FUNCTION   ACTUAL   PREDICTED

YEARS   1950-1990

ACTUAL-PREDICTED WITH FF #51   POPULATION
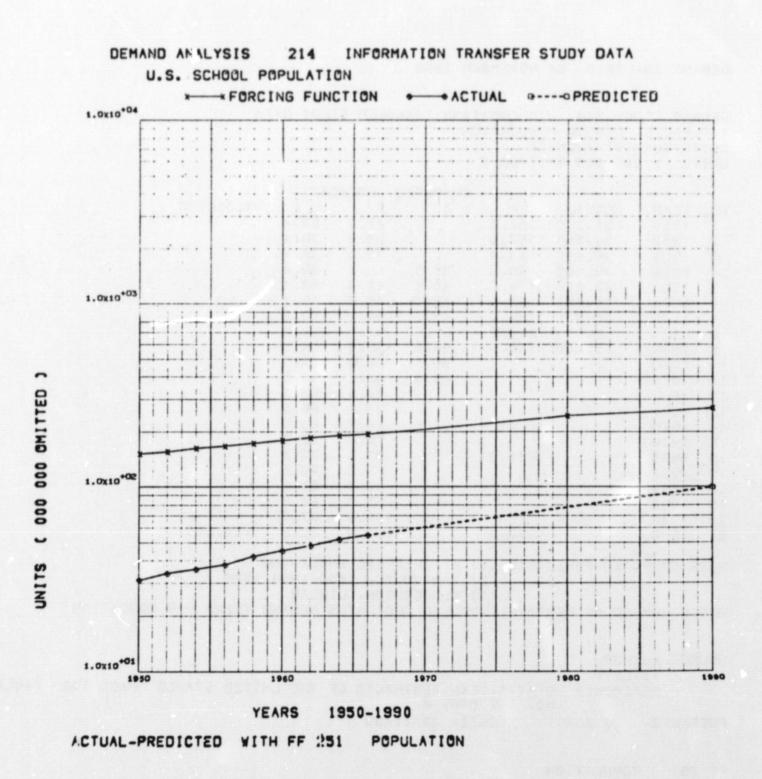
Figure 9 Population Prediction

31

DEMAND CODE   214   INFORMATION TRANSFER STUDY DATA
TITLE-U.S. SCHOOL POPULATION
UNITS/QUANTITY/NUMBER
UNITS (000 000 OMITTED)

NO.	YEAR	ACTUAL	FF	COMPUTED FORECAST 1	2	3	PREDICTED
1	1950	31.300	152.0		31.3	30.4	
2	1952	34.000	157.0		33.8	33.4	
3	1954	36.000	163.0		36.4	36.4	
4	1956	38.000	168.0	39.5	.1	39.4	
5	1958	42.000	174.0	40 4	42.0	42.4	
6	1960	45.200	181.0	42.1	45.0	45.4	
7	1962	48.300	186.0	49.1	48.2	48.4	
8	1964	52.000	192.0	51.8	51.5	51.5	
9	1966	55.000	195.0	54.6	55.0	54.5	
10	1968			59.1	58.6	57.5	
11	1970			61.3	62.4	60.5	
12	1972				66.3	63.5	
13	1974				70.3	66.5	
14	1976				74.5	69.5	
15	1978				78.8	72.5	
16	1980		245.0		83.3	75.5	
17	1982				87.9	78.5	
18	1984				92.7	81.6	
19	1986				97.6	84.6	
20	1988				102.6	87.6	
21	1990		270.0		107.8	90.6	100.000

NOTE-COMPUTED FORECASTS (1) EXPONENTIAL SMOOTHING
                        (2) PARABOLIC, 1950,1958,1966
                        (3) REGRESSION, LINEAR
NOTES-NUMBER OF PERSONS ENROLLED INDICATES DEMAND TREND FOR EDUCATION

SOURCE--AUTHOR-
        TITLE -
        REFERENCE -STATISTICAL ABSTRACTS OF THE UNITED STATES   PAGE 109   TABLE
                NO. 147 PAGE 8
PREPARED-   J BURTT   DATE- 03/11/69

FF 251   POPULATION

Figure 10 Population Basic Data

Regression methodology is described in detail in many texts such as Refs. 10 and 11, but a brief description of the significance of the tool is provided as follows. If, for example, one were to correlate the amounts of food that can be purchased for various sums of money in the local store at a given time, the result should be perfect correlation, with a correlation coefficient of 1.0. Therefore, a chart of amount of food versus money spent should have a nearly linear or proportionate relationship – discounts for large volume purchases would present a perfect correlation.

Carrying the above analyses further, if one were to correlate quantity of food versus expenditures over a two year period, the correlation would be considerably less due to seasonal variations in food prices and economic factors such as inflation. Clearly there is never a perfect correlation, since food prices are a function of time, place, season, weather, supply, demand, and government policy – a very complex relationship. If food purchases are considered on a worldwide basis, the plot of quantity versus dollars becomes more random due to dollar exchange rate variations from country to country. Consequently, the correlation between the two factors becomes weaker as the scope of relationship is enlarged. In a case of extreme emergency, or in a completely primitive society, there might be no correlation between dollars and food obtainable. A chart of food obtained versus dollars may give a completely random scattering of data points and the correlation index would be zero.

The mathematical expression for the correlation coefficient obtained from simple regression analysis is:

$$v = \left(\frac{1 - G_{x,y}^2}{G_y^2} \right)^{1/2}$$

where:

v = coefficient of correlation

$G_{x.y}$ = standard error of the estimated relationship computed between x and y

G_y = standard error of the variable y

Regression analysis was used as a tool to facilitate the prediction and forecasting of future economic parameters affecting the demand for information transfer. Only simple correlations between two variables were therefore made. The results of the correlation served as a subjective guide in analyzing interrelations between variables and in making forecasts where interrelationships appeared to be rational and significant. A more detailed disucssion of the regression analysis is contained in Appendix B.

Demand Trend Evaluation

Historical trends were projected to the year 1990 by means of the mathematical models and computer methods described previously and in Appendix A. The projections were evaluated on the following basis to determine the proper model to be used for forecasting the future trend and to test the validity of the models and their projections.

1. Each model was evaluated for best fit and compliance with the bulk of historical data. The extent to which a particular model does not fit the historical data and the mode of non-compliance is as important as the degree to which different specific models do fit the data. If the data oscillates about the model in a fairly uniform manner for example it is indicative of the model representing the long term trend. A progressive and increasing deviation of the data points away from the model indicates long term oscillations or a progressive difference of trend.

2. Each model was evaluated on the basis of how well the projected trend agreed with authoritative and "expert" forecasts. In most cases published forecasts by prominent economists and trade publications agreed closely with projections of the model best fitting the historical data.

3. The projected trends were evaluated for compatibility with known forcing functions and factors affecting the future course of the trend. Such factors can be sociological, political, economic, technical or scientific. In some cases models were constructed to relate the pertinent and interacting forces affecting the trend. National policy on education and the number of persons in the six to eighteen year old age group for example affects the needs for information transfer for public education. Projections of numbers of grade and high school students cannot continue at the historical trend rate because of the limited available population to be educated. Therefore, the projected trends must be evaluated relative to the limitations and forcing functions acting upon, limiting or controlling the trend.

4. Trend projections were analyzed to determine the extent to which the trend maintained a likely proportionate relationship to the major economic indicators related to the trend. Gross national product and kilowatt hours of electrical production for example are closely related variables which correlate closely over long periods of time and indicate industrial activity and economic growth. Revenues from the sale of electrical power have amounted to approximately two percent of the gross national product from 1950 to 1968. The use of normalized trend relationships such as percentage of GNP were used to evaluate the impacts and effects of the trend projections. The means of studying analyzing such relationships is presented in the subsequent section, Detailed Analysis of Forecasts. Where the relationships between variables were well understood, the correlation coefficients obtained from the regression analysis served as guides in evaluating trends relative to authoritative predictions such as GNP, power production and population.

5. Projected trends were analyzed with respect to the probable benefit and future needs of the nation for the services to be provided. Large benefits and strong needs generate high growth rates. Growth trends of demands for service are therefore closely related to benefits provided due to fulfillment of the need for service. A detailed analysis of supply and demand for each trend curve is not appropriate for this study addressed to the future needs for services which may be fulfilled by a variety of means. Therefore the demand trends for services are best treated by the more general means of evaluation described. The demand profiles for major categories of demand present descriptions of benefits and references pertinent to the demands and future needs and requirements for services. "Analysis and Ranking of Demand Categories by Potential Benefits" presents the relative demand trend growth rates for and expanded set of thirty-two demand categories. This internal working report presents the estimated economic, social and scientific benefits projected for each of the demands and the basis and rationale for the benefits.

In most cases the evaluation of trend projections by the criteria described, provided a rational basis for making a demand trend prediction. Where a reasonable prediction could not be made or where a reasonable doubt existed as to the validity of the best prediction obtained, more detailed analysis was performed as described in the following section to provide a better insight into the problem. The final trend prediction was implemented as described in Detailed Analysis for Forecasts.

Detailed Analysis for Forecasts

Four basic methods were used for refining trend forecasts.

1. Perform additional research for better or more explicit predictions by prominent authorities and sources such as trade publications and government agencies.
2. Research better historical data and trend relationships over longer periods of time.
3. Obtain interviews with users and authoritative persons knowledgeable in the field in order to gain insight into future trends and forcing functions.
4. Plot trend relationships between variables and economic indicators which are considered to be related. Figure 11 shows a typical trend relation chart for number of telephones versus GNP and Figure 12 shows a multiple trend relationship between population, number of telephones, number of students and labor force.

By using these methods it was possible to determine a reasonable trend forecast or at least a forecast which did not seem unreasonable and which had a logical basis in fact for probably occurring. Five basic assumptions were used for all projections, Ref. 8 page 6:

(1) Continuing technical progress
(2) Improvements in social and political relations
(3) Free flow of world trade
(4) There will not be a large-scale war
(5) There will not be a wide spread economic depression such as occurred in the 1930's.

Demand Trend Prediction

The demand trend predictions were generated by determining the most probable forecast values from the trend evaluation and generating the trend forecast on a computer-generated chart. The computer projects an exponential curve between the historical data points and the forecast data point or points. Various models can be approximated by the series of exponential curves. A related trend indicator, designated FF for Forcing Function, is also projected on the chart for reference. The trend relationships between the trend indicators is the key element in comparing the two indicators. The value scale for the forcing function indicator is not always the same, or in the same units as for the trend indicator. The trend projections represent the most probable, i.e., best estimates, of future trends which can be made on the basis of the assumptions described in the previous discussion and the available data. Confidence limits are not needed for the projected trends because such lines of probability for the trends derived would be estimated probability of estimated trends and predictions based upon assumptions of future conditions. There is essentially no available
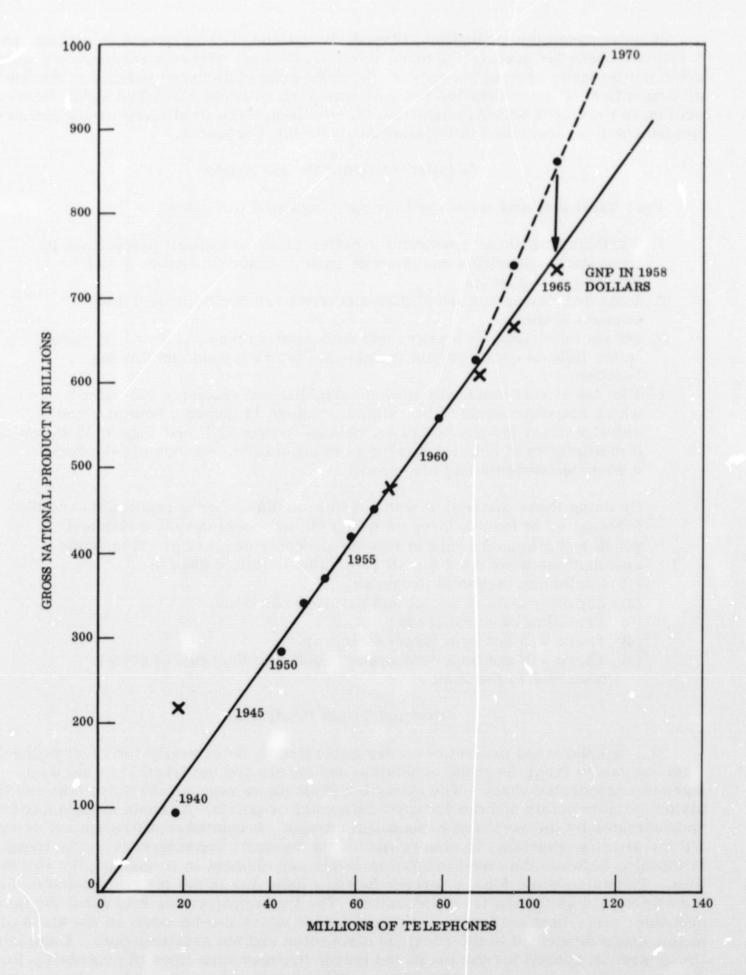
Figure 11 Millions of Telephones
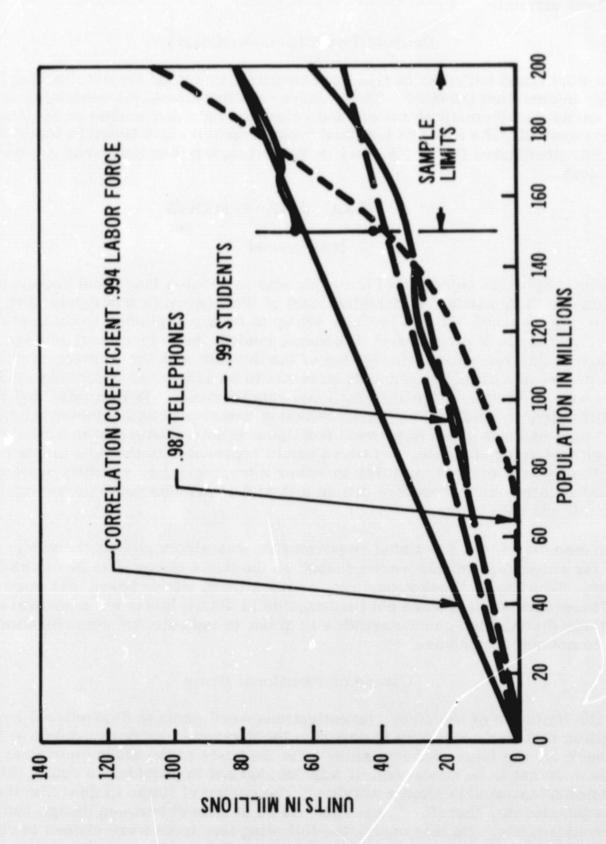
Figure 12 Population Vs Telephones/Students Labor Force

37

probability data on the possibilities of a major war, depression, social crisis, or growth of the GNP in real dollars. Growth of the nation, as reflected in the Department of Commerce's latest long range projections of GNP, Ref. 12 page 312, is considered to be a best estimate.

Demand Trend Indicator Charts

The final trend indicator charts were prepared and used for determining future needs for information transfer. These charts and backup charts containing curves for the various mathematical models and reference data and source were prepared as working material. The titles of the final trend indicators are listed in the Master Demand List, designated DT or FF, and in Table 1 under Demand Trend Analysis — Methodology.

FUNCTIONAL REQUIREMENTS

Background

A very important objective of the study was to develop functional requirements for each category of demands. Accomplishment of this objective was established under Task II of the contract. It was initially set up to be accomplished early in the study; however, as the study progressed, it became evident these functional requirements could only be derived after investigation of the demand and the service required. Since services to satisfy the demands were not to be conceived under this study contract, it was difficult to establish functional requirements. Due to this, and also due to the difficulty, in some cases, in establishing actual data on communications traffic loads, a decision was made to provide functional requirements that indicated relative trends without being absolute, and which would represent, to the best of our knowledge, a type of service without committing to either a terrestrial or satellite system. The functional requirements therefore are an attempt to provide only characteristics and their variations with years.

Commonality of the functional requirements was also a goal of the study; consequently the selected demands were grouped on the basis of common functions called networks. To indicate these groupings, network titles were chosen that were descriptive. These service nets were not investigated in detail; however, a general description of their distribution characteristics is given to indicate the considerations made for the commonality analyses.

Choice of Functional Items

At the initiation of the study, investigations were made to determine the degree of definition that was necessary to describe the demand in sufficient detail to lay the groundwork for the future concept study. On the basis of the study constraint that services were not to be conceived, it was decided not to provide, in detail, functional requirements that would define a service. The choice of items to describe the functional requirements, therefore, was made to be at a level between design and operational requirements. On this basis, the following ten items were chosen to represent the demand.

- Number of users
- Coverage
- Information type
- Channels/Bit Rate

- Message duration
- Message spacing
- Message quality
- Message reliability
- Message priority
- Message privacy

A brief discussion of each item follows:

Number of Users: The original purpose of this item was to indicate number of people benefited by the service if provided; however, in some cases "user" was interpreted as either a receiving or sending terminal, since these numbers were more involved in computing numbers of channels or bit quantities relayed.

Coverage: The unit of coverage refers to a geographical area, such as CONUS or Global, and was for the purpose of providing basic data for antenna concept studies.

Information Type: Designating signal by type, video, voice, or digital, was considered an important breakdown for analysis of data volume and the relative magnitude of these three types.

Channels/Bit Rate: Channels refer to only voice or video information type, while bit rate refers to digital information. Maintenance of data quantity units in channels or bits was considered necessary, from the standpoint of the concept study and the benefit analysis, since converting to one universal unit would lose the information identity and would always lead to a debatable point regarding conversion factors. Although the use of channels for voice or video is self-explanatory, the bit rate does require explanation. Bit rates given were not proposed as a design rate but rather as the bit rate to be used when computing the quantity of bits to be transferred per message per day or year. A decision as to what the design bit rate should be is very much dependent on many design factors, such as modulation techniques, multiplexing, and handling of the signal, and is therefore left to the concept study.

Message Duration: Although duration of each message was provided to indicate the length of each message, it also provided the basis for computing message quantity. The duration was computed in most cases on the basis of message content presently transmitted, however this was modified in some cases by the fact that present day techniques are not always the most efficient and therefore the estimate was made on the basis of what it could be under better conditions.

Message Spacing: The spacing of messages is provided as a basis for computing quantity of data to be transmitted on a daily, weekly, or yearly basis and should not be construed as a design requirement. It can provide an indication of the rapidity of the messages; however, the same license (present conditions) was taken as indicated under message duration.

Quality of Message: Since three types of information are transmitted, three quality figures are provided. The scales for video, voice, and digital signals are as follows:

Video (based on signal to noise)	Voice (based on signal to noise)	Digital (based on error rate)
42 DB - TASO 1 Excellent	20 DB - Low	10^{-6}
37 DB - TASO 2 Good		
31 DB - TASO 3 Average	30 DB - Medium	10^{-5}
26 DB - TASO 4 Poor		
20 DB - TASO 5 Passable	45 DB - High	10^{-4}

Reliability: The figures provided are given as relative indicators and are not to be construed as absolute figures. Early in the study it was recognized that different demands would require various reliabilities when compared with each other; consequently, this information indicates relative requirements and is not based on firm absolute data.

Privacy: Much of today's data handling involves "Personal" data entrusted to and in the care of governmental or service agencies. Other data are private from a company "proprietary" point of view. In these cases, special handling requirements must be provided by the network and are so indicated, as high, med, low.

Priority: Relative priority of information is indicated by this functional requirement. Since it is relative, it is recorded as either top, high, medium, or low.

Accomplishments

Using the above functional requirement titles, assignments were made to the 31 most promising demands (selected by a method accomplished under Task III), plus the following demands which were selected prior to the "most promising" evaluation.

1 Ocean Fishing	6 Ship Position, Commercial
2 Aircraft Communication, Private	7 Law Enforcement
3 Crop Surveillance	8 Library, National
4 Weather Station Data Relay	9 Securities Quotations
5 Communications, Ships, Commercial	10 Securities Transactions

11 Hydrology

Functional requirements for all of these demands are shown as working material. A summary of the functional requirements for the 31 most promising demands is provided under summary of results. To exemplify the working material necessary to prepare the summary functional matrices that are provided in this report a sample demand functional requirement matrix is shown as Figure 13.

Methodology

The basic functional requirements are derived from the profiles which are related to other data sources and the econometric operations relations that are shown in the model, Figure 14. This model exemplifies the method used to determine the utilization rate or the functional requirement of "Aircraft Users" from 1970 to 1985. Following the model through, the aircraft navigation concept for the three time periods 1970, 1975, and 1985 were derived first from the profile descriptions and technological trends and avionic sales. These concepts would influence the number of aircraft five and fifteen years from now. In addition to this approach, it was necessary to consider the impact of aviation revenues, airline traffic, and passenger miles. Consequently, a projection of each one of these indicators was made by using forecast curves of forcing functions such as GNP, population, and accident rates that were previously tested for correlation. Projecting the number of aircraft for the three time periods and applying a utilization factor, the number of aircraft movements modified by the area of operations was derived. Knowing this utilization rate and applying navigation message duration and spacing characteristics, the bits/day were obtained.

Computer Catalog Page

Example

DEMAND-   ENROUTE AIR TRAFFIC POSITION, COMMERCIAL
CODE- 086
DESCRIPTION-GROUND-AIR-GROUND DIGITAL LINKS BE-
TWEEN AIRCRAFT AND ATC CENTERS.

	1970	1975	1985
NO. OF USERS	1077	1307	1645
COVERAGE/LOCATION	GLOBAL	GLOBAL	GLOBAL
INFO. TYPE	DIGITA	DIGITA	DIGITA
BANDWIDTH/BIT RATE	2400BS	2400BS	2400BS
MSG. DURATION	1 SEC	1 SEC	1 SEC
MSG. SPACING	30 MIN	15 MIN	5 MIN
MSG. QUALITY	10-6	10-6	10-6
MSG. RELIABILITY	.999	.999	.999
MSG. PRIORITY	HIGH	HIGH	HIGH
MSG. PRIVACY	LOW	LOW	LOW

REMARKS-USERS ARE ENROUTE AIRCRAFT OVER CONUS AND
THE ATLANTIC AND PACIFIC OCEANS.

REVISION-1 JUN 5, 1969   PAGE

Figure 13 Sample Functional Matrix
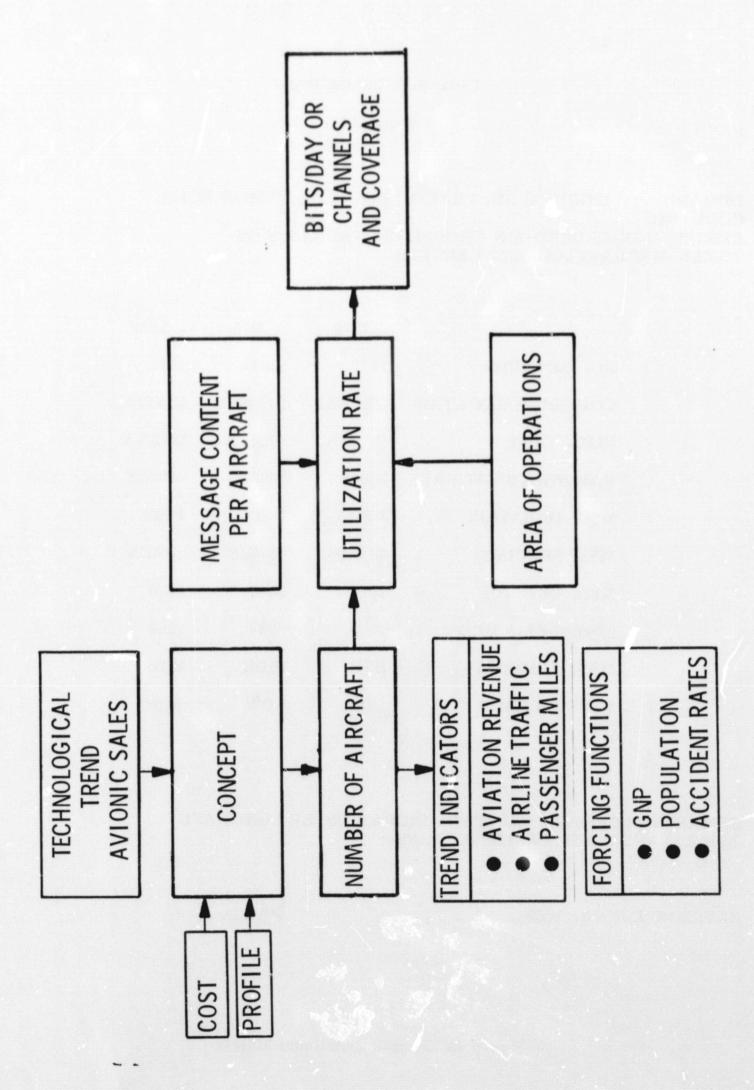
Figure 14 Model for Determining ITS Requirements

Applying the above factors leads to a subjective analysis which included the consideration that the numbers of aircraft will tend to increase at a rate proportional to the growth of the national economy. The airline traffic, passenger miles, GNP, and population are all indicators of the national economy growth and consequently can be used to predict numbers of aircraft. From these data, the number of aircraft movements over CONUS and the Atlantic and Pacific Oceans were predicted to be 1077 in 1970, 1307 in 1975, and 1645 in 1985, assuming 1976 Jumbo Jets predominate air traffic through 1985. The area of coverage was considered essentially global.

Although the transfer of information for air traffic control is accomplished predominately by voice today, position of aircraft can and is determined in some cases by a modified digital or analog method. It was concluded that eventually all information transferred would be represented by digital type, so that a growth relation could be shown from the year 1970 to 1985. Consequently the following message contents were considered — taken from Air Traffic Control operational data:

Message Type	Avg. Duration (Sec)	Infor. Vol (Bits/Msg)
Position Report	45	225
Clearance Control	15	60
Vectoring	10	60
Aircraft Tr affic	10	250
Terminal Status	5	100
Weather Advisory	10	200
Totals	95	895
Average	16 sec	149

For 1970 estimate, an average ATC message was considered to be 16 sec long and contain 149 bits per message, or 149 x 16 = 2384 bits/message.

Taking into account technology advancements, it can be projected that the spacing of the above message would be 1 message/half hour, for a 600 kts aircraft giving position data every 10 ft of longitude change in 1970. This would increase to a message every 5 minutes in the 1985 era, based on a 5 ft longitudinal error. Since approximately 2400 bits is contained in each message, if a bit rate of 2400 bits/sec is chosen as representative of present day capability this would mean the amount of digital data could be transferred today within 1 sec every 30 min. No change is anticipated in message content in the ensuing years but, as stated, the information will be provided more often to reduce "wandering" or longitudinal error. It is anticipated this will increase to a message every 15 minutes in 1975 and one every 5 minutes in 1985. Consequently, a bit volume per day for total user traffic vs. year is projected, as shown in Figure 15. For 1970, the 2400 bits per message is provided 48 times a day for 1077 aircraft users, or 2400 x 48 x 1077 = 124 x 10^6 bits/day. On this same basis the volume of bits/day for 1975 would be:

2400 x 96 x 1307 = 300 x 10^6 bits/day.
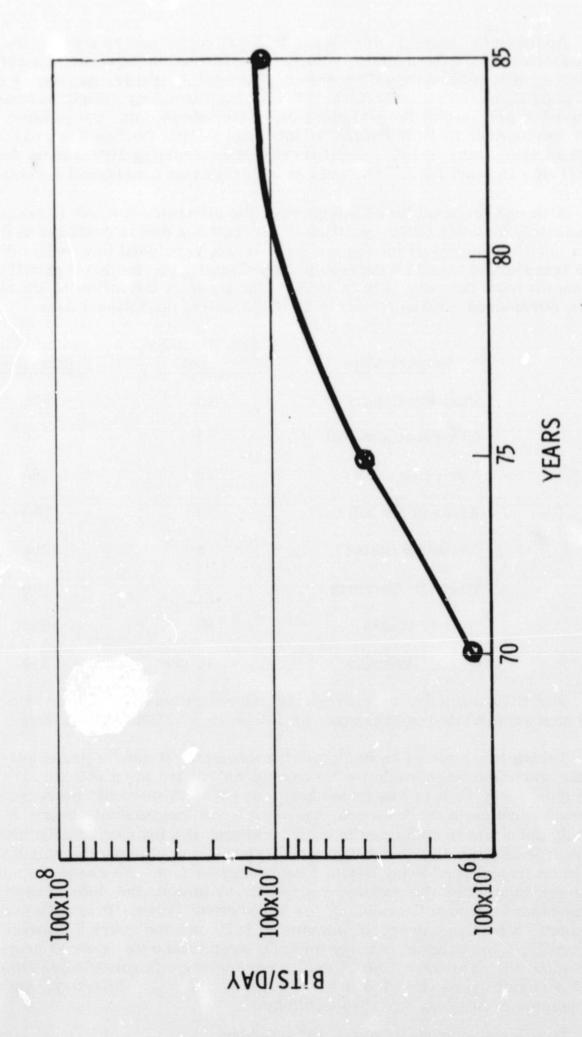
Figure 15 Enroute Information Transfer for Air Traffic Control

44

For 1985 it would be:

$$2400 \times 288 \times 1645 = 1140 \times 10^6 \text{ bits/day}$$

Due to position data accuracy requirements; that is, between 100 to 600 ft, it is anticipated the error rate should not exceed 10^{-6}. Due to the fact that life is dependent on reliable position data during emergency conditions, the reliability is indicated at .999. Message priority was conceived to be high since there is always an emergency requirement for rescue data. Privacy was considered low since the information to be provided should be useful to all aircraft in the user's vicinity for collision avoidance purposes.

Information Networks

Further analysis of all of the functional requirements permitted an additional breakdown that indicated commonality by grouping the demands under various networks. Various descriptions were tried and demand categories were segregated under these functional network titles. However, the commonality analysis of the functional requirements provided five network titles that would cover all demands. They were as follows:

1. Information Dissemination and Broadcast
2. Data Collection and/or Distribution
3. Inquiry and Response
4. Computational
5. Personal Information Exchange

These five types of networks will satisfy any one of the demands that have been studied. Although basically and objectively different, the networks do have overlapping characteristics. Cataloging the demand categories in accordance with a particular network was accomplished and is provided as follows:

INFORMATION NETWORKS

Networks	Demand Category
I – Information Dissemination and Broadcast	Education Broadcast
	Teleconferencing
	Civil Defense Warning & Communications
	Electronic Publishing
	Judicial Proceedings Broadcasts
	News & Broadcast Distribution
	Commercial Broadcast
	Cultural Programs Domestic & Intl.
	Religious Exchange
	Time Signals Broadcasts
	Amateur Radio Broadcasts

Networks	Demand Category
II – Data Collection and/or Distribution	Marine Data Handling
	ᴖpace Programs Data Relay
	Weather Data Relay
	Aircraft Data Handling
	Oceanographic Data Relay
	Earth Sciences Data Relay
	Ground Traffic Data Handling
	Rescue Data Handling
III – Inquiry & Response	Library Data Handling
	Medical & Health Data Transfer
	Law Enforcement Data Transfer
	Welfare Data Handling
	Statusing of Goods Data
	Electronic Mail Transfer
	Language Translation
	Banking & Financial Data Transfer
	Data Securities Exchange
	Government Auditing Data Transfer
IV – Computation	Computer Data Handling
V – Personal Information Exchange	Pt. to Pt. Telecommunications

Since the network concept is new, the terminology used in this study had to be evolved and is presented in the following paragraphs.

Inquiry and Response

This type of network is typified by such demand categories as: Library, Medical, Welfare, and Securities Exchange. A large number of specialized terminals are capable of making an inquiry of a single repository of information which is capable of retrieving the requested information and responding to the inquiry. Since each terminal within a net would always make its inquiry of a centralized terminal for an area, this service would most likely be two-way point-to-point distribution net.

Information Dissemination and Broadcast

This net is typified by the following demands: Education, Commercial Broadcasts, Newspaper and Electronic Publishing. It provides a transfer of information between many terminals and one centralized terminal. It does not have the capability of handling an inquiry and then responding, since it would be a one-way transfer of information on a point-to-multipoint basis. It would be capable of storing information for short periods of time to allow for dissemination of the information at a more appropriate time.

Data Collection and Distribution

This net is for the purpose of collecting data from many sources and then relaying the information to other terminals. It may store the information for short periods of time and then relay it; however, in most cases it would operate in real time. The net

46

can be exemplified by the following demands for services; Air Traffic Control, Space Programs Telecommunications, Earth Resource Data Collection, and a Meteorology Data Relay. The terminal description is a multipoint-to multipoint type of distribution service.

Computational

This type of net includes time sharing in the strictest sense of the term. It has the characteristics of sharing a computer's time among a group of users and is closely allied to the inquiry and response except it has the capability of not only giving a response to an inquiry but also digesting data and making computations on these data and then providing the answer. The distribution service is a two-way point-to-point type. By its title, this type of net would handle only data that are to be processed; consequently, this net was derived with a great deal of consideration for the handling of the data at the terminals. Examples of demands this type of net would satisfy, are: Scientific Computations, Home Information Center, Automated Design.

Personal Information Exchange

The voice telephone net is the best example of this type of service. It has two very definite characteristics, it is usually accomplished from a point-to-point terminal and the information exchange is personal.

The above five networks were described not only by the type of information distributed but also by a characteristic distribution system which can be broken down into the following four basic patterns: (Ref. 13)

1. Point to one other point.
2. Point to multipoints.
3. Multipoints to point.
4. Multipoints to multipoints.

The word "multipoints," may refer to any number from two to several hundred or more. The more points, of course, encompassed by the distribution pattern, the more complicated the design problem. For purposes of illustration, "multi" will be exemplified by an eight-point pattern. These various distribution patterns are illustrated in Figure 16.

The point-to-point pattern is very simple. The flow of information may be in one direction only, in either direction alternately, or in both directions simultaneously. In communications terms, these directional flows are called one-way, half duplex, and duplex (sometimes full duplex) transmissions, respectively.

The choice of communications channel type depends upon the volume of data that will flow between the two points.

The point-to-multipoint pattern is used in systems where (1) information is disseminated to many locations from one centralized office, or (2) the centralized location initiates calls to outlying locations and the information is returned from these locations. An example of the first type is a weather broadcast network which sends out weather reports to many stations.

In the second type, the central location periodically calls each outlying office. Since the calls are made on a regular schedule, the personnel at each office know when to expect their calls and the operators can have their information ready for

Pt-to-Pt

Pt to Multipt

Multi-point to Point

Multi-to-multi-point (direct line connection)

Multi-to-multi-point (switched connections)

Multi-to-multi-point (party line connection)
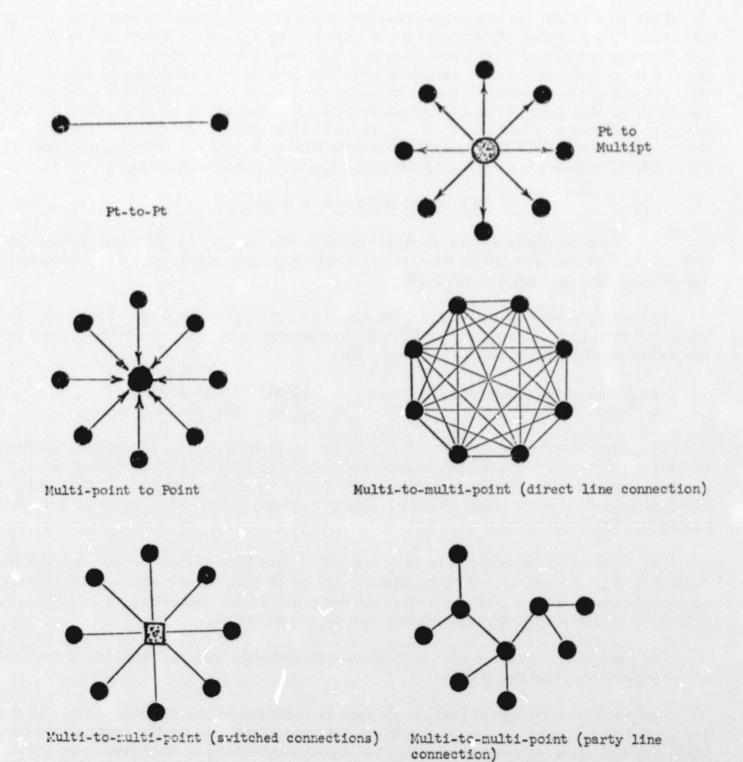
Figure 16 Basic Distribution Patterns

transmission when called. This reverse flow of information, however, does not change the basic one-to-many distribution pattern because the calls still emanate from one location.

The type of channels to be used in this net again will be determined by the volume of information to be transmitted. If the volume is great enough it may be necessary to extend private lines to each of the outlying locations.

The third basic classification is the multipoint-to-point pattern. As in the previous point-to-multipoint, it is the direction of calling which determines the distribution pattern. A typical case is an inquiry net where many locations call into a computer for information. In this case, the desired replies flow outward from the computer in response to the inquiries.

In other cases, the direction of calling and the flow of information are the same. For example, sales offices may initiate calls to a centralized data processing center and transmit sales orders for further processing.

The multipoints-to-multipoints distribution is the most complex of the four basic distribution patterns. Every point in the system can send and/or receive information from every other point in the system. In Figure 16 the pattern is shown as if there were a direct line between each of the many points. This is the situation in which the early telephone companies found themselves when they tried to interconnect every customer with every other customer. This system soon proved to be uneconomical, and switching centers were established to provide temporary connections between the calling party and the party being called. This arrangement permits economical application of the basic distribution pattern of many points to many points. In this arrangement, every location is connected to the switching center via a direct line. When information is to be sent to any location, the calling station identifies (by dialing or using special address codes) the called station, and the switching center acts as the point of connection for the two lines. After the information has been transmitted, the connection between the two lines is broken.

There is one other method of interconnecting many locations so that any station can send or receive information from any other station. This method provides for the connection of all the stations on a party line arrangement. In its simplest version, every message sent on the line is received at every location. It is possible, however, for each station to have its own special address code, and any station wishing to send a message can first send the Call Directing Code. This CDC will activate only the equipment located at the intended receiving station; all other stations will remain turned off. Only the proper station, therefore, receives the message. Again the basic distribution pattern of many-to-many has not changed even though the method of handling the information is different. This arrangement usually utilizes private lines to connect the stations.

In each of these basic distribution patterns, the volume of information to be handled is a significant factor. In a large communication system, variations in volume between the different points may dictate that more than one distribution pattern be employed. In the final analysis, the volume of information to be transmitted between the various points determines the most feasible communication net. To summarize these network characteristics, Table 2 is provided.

Table 2

SUMMARY OF INFORMATION TRANSFER SERVICE NETS CHARACTERISTICS

	Distribution Pattern	Transmission Direction	Storage Capability	Magnitude of Centralized Terminals	Signal Transfer Reqs.		Response Characteristic
					Processed	Relayed	
Information Dissemination and Broadcast	Pt to Multipt	One Way	Short	Few		X	Immediate
Data Collection and Distribution	Multipt to Multipt	Two Way	Short	Many	X		Relative Short
Inquiry and Response	Pt to Pt	Two Way	Long	Few	X		Medium
Personal Information Exchange	Pt to Pt	Two Way	None	Many		X	Immediate
Computations	Pt to Pt	Two Way	Long	Many	X		Medium

PRELIMINARY RANKING AND SCREENING OF DEMANDS

Background

During the initial phases of study, several significant actions were taken to organize and put in order the internal operations. Although they were stipulated in the work statement requirements of the study, they also became very practical actions to maintain control of the many items of information being digested and evaluated in a relatively short period of time. First, demands were being identified and compiled into lists on an individual basis. As their numbers grew to several hundred, it became mandatory to organize and order them into groups or categories. Secondly, preliminary ranking to the initially developed list had to be undertaken on a test (or preliminary) basis to prove out the method. Thirdly, the demands had to be screened so those unimportant items would not be carried forward unnecessarily. These items produced preliminary results which were documented by LMSC and reviewed at the time by the NASA study monitor. However, many of these results have been superseded by subsequent activities in the later phases of the study. It is considered worthwhile to document these activities and the resultant benefit estimates derived in this final report. However, where intermediate results were superseded, they are not included here in their preliminary form. Each of the three intermediate activities are discussed in the following sections.

Preliminary Ranking

One of the early requirements of the study was to establish criteria, rationale, and methodologies as tools leading to the basic selection of promising demands. One of the major sets of criteria, rationale, and methodology was to evaluate and rank the demands which were being identified. During this first two and one-half month period, several methods for ranking were proposed, discussed, and refined. A preliminary ranking of demand categories and demand groups was completed and evaluated, the results were significant and were documented and discussed with the study monitor. They are not presented in this report since their value was not in absolute rankings, as such, but rather as a preliminary screening for the final Benefit and Service Implementation Rankings, which will be discussed in detail in the following section.

Screening of Demands

One of the requirements of the study was to continuously review the list of demands generated against a preliminary set of criteria, parameters, and methodology in order to screen out futile and unimportant items. This was accomplished and was recorded in two ways. The criteria for screening was definitized and the rationale established and recorded as a separate study effort. Secondly, the Master Demand List, previously discussed in this report was coded to identify the fact the demand was dropped. The Demand Sequence number assigned to the demand that was dropped was never reassigned or used again.

Criteria for Screening

The purpose of screening the demand list is to remove those demands which are superfluous for the detailed analysis phases of evaluation. By screening out demands in accordance with the criteria presented, a more thorough and worthwhile analysis

can be made of the significant demands remaining. The screening criteria, designated SC, are as follows:

SC-1   The demand is related to or functionally filled by the military.

SC-2   The demand is in a sensitive area of security.

SC-3   The demand is related to foreign governments and their interests such as to be outside of the scope of an information transfer study with predominantly domestic benefits.

SC-4   The demand has a very narrow and limited applicability in comparison with the demands and negligible and/or highly questionable benefits.

SC-5   The demand utilizes short distance and local communications which appear capable of adequately fulfilling demand requirements for the foreseeable future or until a radical improvement of relevant communications capability occurs.

SC-6   The communications and data transfer serve highly constrained and tightly controlled operations within a fixed area under local supervision and control.

SC-7   Existing local and regional communications between fixed points of an established and stable network handling large volumes of information with a minimum flexibility.

SC-8   The demand is sufficiently described by another demand such that this listing is essentially redundant and is considered superfluous.

In addition to these criteria, additional and more detailed rationale are appropriately listed with each of the screened out demands. All of the demands presented in Table 3 are screened out on the basis of SC-8 except where noted as being otherwise.

Table 3

SCREENED OUT DEMANDS REMOVED FROM ACTIVE CONSIDERATION

Master Demand List No.	Title and Remarks
003	Law Enforcement, Interrogation — Utilizes telephone and requires legal and judicial acceptance for increased utilization.
004	Law Enforcement, Crime Investigation and Analysis — Utilizes telephone and records for 002
005	Law Enforcement, Rapid Real Time Positive Identification — Essentially the same as 001
015	Educational, Pre-School — Program Head Start — Essentially the same as 006
019	Education, Gifted — Provided by improved education and cultural programs
020	Educational, College-Scientific, Medical — Essentially the same as 010
021	Education, Business, Legal, Arts, etc. — Included within 008, 009, 010
022	Education, Post Graduate — Same as 010
024	Education, Unemployed, Foreign Born — Contained in 023
025	Education, Criminal Rehabilitation — Contained in 013
026	Educational, Police Education and Instrument — Same as 014
031	Medical, Smog Monitoring — Combined with 030
033	Medical, Health, Education and Welfare Network — Provided by 030 and 067
034	Medical, Smog Studies and Control — Contained in 030 and 179
035	Medical, Medical and Health Network — Dropped, Criteria SC-5

Table 3 (Continued)

Master Demand List No.	Title and Remarks
037	Banking, Credit Cards — Contained in 039 and 040
038	Banking, Identification — Contained in 040
044	Ground to Ground Telecommunication, Long Distance Telephone — Contained in 042 and 043
046	News, Daily Papers — Combined with 045 as a total news service
047	News, Layout — Contained in 048
055	Mobile Ground Communication, Trucks — Combined with 054
056	Mobile Ground Communication, Buses — Combined with 054
057	Mobile Ground Communication, Trains — Dropped, Criteria SC-5 and -6
064	Library, Scientific Data Network for NASA, Bureau of Standards, etc. Combined with 060
065	Library, Business and University Scientific Computer Network — Combined with 060
066	Library, Patent Service Search, Retrieval, Display Status — Contained within 063
071	Welfare, Urban Land Utilization, Development Planning — Contained within 070
072	Welfare, Health, Education and Welfare Network — Contained in 067, 068, 069 and 070
073	Welfare, General, Adult Education, Welfare, Unemployed — Contained in 023
076	Securities Exchange, Stock, Bond and Commodity Quotations — Contained in 075
077	Securities Exchange, Securities Control Network, Iss. of Sec. — Contained in 074
082	Weather, Satellite Control and Data Relay — Contained in 080
085	Weather, Monitoring Air Masses by Balloon Transponders — Contained in 078
089	Enroute Air Traffic, Air Traffic Control — Combined with 086, 087, 088
093	Communication (Ships), Precision Navig. Comm. Sys. for Air and Ships — Combined with 095
094	Communication (Ships) Ship-to-Shore Communications Link — Contained in 090, 091 and 092
109	Oceanographical, Wave Studies, Sea State, Tidal Waves — Combined with 107
112	Selected Entertainment, Commercial Radio and Television — Contained in 110 and 111
116	Meetings, Private — Contained in 042 and 043
119	Meetings, Political Actions, United Nations, Conventions — Contained in 115
121	Meetings, United Nations Sessions, Broadcasts-Blobal — Contained in 114
125	Meetings, "Hot Lines" to Foreign Governments — Contained in 118
126	Meetings, Heads of State, 3-D U.N. Meetings and Presentations — Combined with 118
127	Meetings, Three Dimensional Color Video Conference Service — Contained in 115, 117
128	Meetings, Private, Business, Union, E.C. — Contained in 117, 124

Table 3 (Continued)

Master Demand List No.	Title and Remarks
135	Inventory Control Raw Materials — Contained in 139
136	Inventory Control Finished Products — Contained in 139
137	Inventory Control, Statusing, Exchange of Data, Interrogations — Contained in 139
138	Inventory Control, Auditing and Control Network-Inventories, etc. — Contained in 139
140	Freight Movement, Truck — Contained in 139
141	Freight Movement, Train — Contained in 139
142	Freight Movement, Air — Contained in 139
144	Freight Movement, Control Monitoring and Statusing of Goods — Contained in 139
146	Agricultural — Contained in 147
149	Geological, Survey and Topography — Contained in 148
151	Hydrology — Contained in 152
155	Civil Defense and Emergency Broadcast — Combine with 153
156	Time Signals — Contained in 157
158	Cultural Program, Domestic — Contained in 161
160	Cultural Program, Cultural Exchange — Contained in 159
165	Migratory, Fish and Game Location and Management — Contained in 162, 163 and 164
166	Court Proceedings, Criminal — Contained in 168
167	Court Proceedings, Civil — Contained in 168
170	Computer, Real Time — Contained in 169
171	Computer, Logistics — Contained in 169
172	Space, Missions, Manned Orbital — Contained in 175
174	Space, Missions, Unmanned — Contained in 179
180	Space Missions, Ascent Tracking, Data Relay and Control — Dropped Criterion SC-1, SC-6 and partially contained in 179
184	Space, Missions, Iceberg Monitoring — Contained in 173
186	Space Missions, Glacier and Snow Conditions — Contained in 173
189	Ground Traffic Control, Position and Direction, for Low Speed — Contained in 187 and 188
190	Forestry Services, Survey, Management — Contained in 172
229	Education, Home for Ailing — Contained in 016
230	Medical, Home Diagnosis and Monitoring — Dropped SC-5 and -6
234	Reservation Service — Accommodation Presentation — Contained in 133
235	Commercial Services Information Re trieval — Contained in 060
133	Scheduling and Status, Hotels — Contained in 139
242	Centralized Personnel Records — Screened out, included in Welfare and Social Security Records for Government records
243	Corporation Records — Part of corporate management information systems, SC-6 and -7.
244	Remote Sales — Contained in commercial TV and telecommunications
245	Market Analysis — Contained as part of 139, Inventory Control, Monitoring and Statusing of Goods, and 060, Special Libraries
250	Automated Legal Search Libraries — Contained in 060

Table 3 (Continued)

Master Demand List No.	Title and Remarks
251	Automated Security Systems – Contained in 074
252	Special Government Technical Information Centers, NASA, Bureau of Standards, FAA, FCC, Department of Agriculture, Department of Health, Education and Welfare, Bureau of the Census, Smithsonian Institute, Library of Congress, etc. These functions are contained in 060 Special Libraries.
253	Automated Resources Management Center – Contained in 139, Inventory Control Monitoring and Statusing of Goods and Services.
254	Monetary Value Transfer and Accounting System – Contained in 041
257	Health Education, Child Care, Sanitation, Drug Dangers, Dietary Needs, Food Preparation, etc. – Contained in 023
258	Department of Agriculture Education Programs and Bulletins on Crop Diseases, Improved Agricultural Practices, etc. – Contained in 010
260	Programs for Americans Overseas – Contained in 159, Cultural Programs, International

A review of the above table reveals that only two demands were dropped by criteria SC-1. None were dropped by SC-2 and 3. SC-5 and SC-6 contributed to dropping 5 demands. SC-7 contributed to the dropping of only 1 demand. The remainder, over 80 demands were dropped due to the combination of SC-4 and SC-8. The combining of these many demands in turn resulted in the fact that the demand itself was not dropped in a majority of cases; rather, they were combined with similar demands. The number of identified demands dropped as the result of the above screening from 226 to 134 demands; however, in reality they should not be considered as dropped since they were combined. The 134 demands resulting from this screening were carried forward through the study to the point of selecting the most promising demands.

The distribution of the resulting 134 demands amongst their respective demand categories is shown in Table 4.

ANALYSIS AND RANKING OF DEMANDS BY POTENTIAL BENEFIT

Background

Building from the methodology and tests developed during the preliminary analysis, the final ranking methods were established and documented. The ranking of the demands was also accomplished initially for the thirty-two demand categories and the results were documented and distributed for review. This ranking was updated and expanded using the same methodology on the 134 screened demand candidates, rather than the 32 Demand Categories. The details of the final methods and final rankings are discussed in subsequent sections. Intermediate results are not presented in this final report.

Purpose and Scope

This ranking is oriented toward evaluating those demands which provide significantly improved social, economic, or scientific benefits to the nation through the application of communications technology. Only existing and proven technology, or

Table 4

ITS DEMAND CATEGORIES

No.	Categories	No. of Demands
1.	Space Programs Data Relay	9
2.	Weather Data Relay	5
3.	Oceanographic Data Relay	5
4.	Earth Sciences Data Relay	7
5.	Aircraft Data Handling	8
6.	Marine Data Handling	8
7.	Rescue Data Handling	1
8.	Ground Traffic Data Handling	6
9.	Statusing of Goods Data	3
10.	Computer Data Handling	6
11.	Point-to-Point Telecommunications	2
12.	Teleconferencing Data	10
13.	News and Broadcast Distribution	2
14.	Electronic Publishing	2
15.	Language Translation	2
16.	Commercial Broadcast	2
17.	Cultural Program — Domestic	2
18.	Cultural Program — International	1
19.	Education Broadcast	13
20.	Library Data Handling	6
21.	Welfare Data Handling	4
22.	Health and Medical Data Transfer	5
23.	Law Enforcement Data Transfer	4
24.	Electronic Mail Transfer	2
25.	Government Auditing Data Transfer	7
26.	Banking and Financial Data Transfer	4
27.	Data Securities Exchange	2
28.	Civil Defense Warning & Communications	2
29.	Amateur Radio Broadcasts	1
30.	Religion Exchange	1
31.	Judicial Proceedings Broadcasts	1
32.	Time Signals Broadcasts	1
		134

that which is under development, was considered to maintain the assumptions at a minimum. The analysis is designed to rank the demands according to benefits without regard to the specific types of systems employed, and has been intentionally deemphasized relative to any specific system. An additional analysis ranks demand categories relative to service implementation considerations. The scope of the benefit analysis and ranking was to consider only pertinent demands for the 1975-1985 time frame.

Methodology

The analysis was performed in accordance with the methodology and rationale which evolved, and was discussed and reviewed over a period of about four months. Each demand is rated by nine (9) unweighted parameters of benefit. The sum of the ratings for each parameter determined the rank of each demand. Table 4A identifies the nine parameters and value scale. The maximum score parameter is 5 and the lowest 1. The maximum demand rank is 45, the lowest 9. The parameters shown were selected on the basis of three prime factors.

- Parameters 2, 3, and 4 evaluate means and resources for implementation and the social environment which permits the development and use of the service. The importance of a demand is dependent upon the availability of the technology and the means of providing the functional capabilities for meeting the demands in the 1975 to 1985 time period. Ease of implementation of services to fulfill the demand is dependent upon relative costs of system implementation and operation, required social changes and social acceptance, available technology for implementing new services, or improvements of existing services.
- Parameters 1, 5, 6 treat potential benefit as indicated by the trends of demand indicators and numbers of potential users and beneficiaries. These parameters provide an indication of the strength and needs for those benefits which justify and drive the demand.
- The third factor includes parameters 7, 8, and 9 and covers predictions and forecasts of social benefits which are desirable to balance the rating of the demand trend indicator. Demand trends are based upon the type and character of service which has been available. They cannot exactly forecast the future and may suffer discontinuities due to abrupt technical innovations. The predicted future benefits to the nation (social, economic, and scientific) are dependent upon future services. Technological and economic benefits are considered because ideally they will generate social benefits. Science is considered as an entity because it is one of the key elements producing present day wealth and social affluence.

Table 4A

RANKING PARAMETERS AND VALUE SCALE

Parameter	Value Scale	Parameter	Value Scale
1. Trend Rate	1-5	6. Potential Beneficiaries	1-5
2. Technical Availability	1-5	7. Social Benefits	1-5
3. Ease of Implementation	1-5	8. Economic Benefits	1-5
4. Social Acceptance	1-5	9. Scientific Benefits	1-5
5. Number of Users	1-5		

The parameters selected are designed to provide redundancy and comprehensiveness in the ranking. If a strong demand trend exists, then the demand must have social or economic benefits for significant numbers of people. Benefits, both present and future, provide the driving forces which generate demands. Therefore, a strong demand should rank high in at least three of the nine parameters, i.e., strong demand trend, considerable number of people benefited, and important total benefits. The interrelationships between the ranking parameters provide redundancy within the ranking methodology. The historic demand trend and projected future trends should generally correlate with the expected benefits.

Criteria for Rating of Parameters

Each of the demands is rated in accordance with the criteria, as presented below, for each of the nine parameters.

Trend Rate

Demand Trend and forcing function indicators were identified in the earlier "Demand Trend Analysis" section of this report in relation to the thirty-two demand categories. Charts presenting trend forecasts for each indicator were prepared during the course of the study, covering the period from 1970 (and prior) to 1990. These charts formed the basis for demand trend ratings. The criteria for rating these indicators were as follows:

Rating	Criteria
5	Trend indicator growth greater than 14 percent
4	Trend indicator growth 7 to 14 percent
3	Trend indicator growth 3 to 7 percent
2	Trend indicator growth 0 to 3 percent
1	Decrease to 0 percent

Technical Availability

5	Technology and hardware capabilities proven in extensive functional use.
4	Technology and hardware entering or undergoing operational evaluation.
3	Technology tested in the laboratory and undergoing development
2	Required technology in the experimental stage.
1	Technology concepts envisioned as possible by 1975 or 1980.

Ease of Implementation

5	Implementation is in progress.
4	Implementation is imminent
3	Cost and problems of implementation are justifiable on basis of comparison with improved benefits, operating costs of present services, and needs for investment to increase services and capabilities.
2	Implementation appears practical and possible with available technology.
1	Implementation is estimated to be difficult with serious problems related to technology and cost.

Social Acceptance

Rating	Criteria
5	Implementation appears to be socially acceptable.
4	Plans for implementation will be questioned and cause slight anxiety and resistance.
3	Implementation will be resisted to preserve the status quo, economic and vested interests associated with present operations and services.
2	Implementation of the system will present serious social or political problems which will have to be resolved or negotiated before the system becomes fully accepted and operationally effective.
1	The system appears to be socially unacceptable in the foreseeable future.

Number of Users

Rating	
5	Greater than 100 million people.
4	10 to 100 million people.
3	1 million to 10 million people
2	100 thousand to 1 million
1	0 to 100 thousand people

Potential Beneficiaries

Rating	
5	Greater than 100 million people
4	10 to 100 million people
3	1 million to 10 million people
2	100 thousand to 1 million
1	0 to 100 thousand people

Benefits have been grouped into three classes; social, economic and scientific. The rating of demand categories relative to benefits is dependent upon the direct influence of information transfer in producing a benefit. The benefit predicted must be derived from the implementation of a new or improved information transfer system.

System Characteristics

The characteristics of the system available for adoption are as follows:

- Capable of direct point-to-point communication over long distances.
- Cost of communication essentially independent of communication distance.
- Cost of communication equal to the cost of existing long distance terrestrial communications at a distance of 500 miles.
- Large area of coverage.
- Capable of transmission to moving vehicles.
- Capable of providing high frequency digital and video type communications for information transfer.

Sources of Benefits

Communication and information transfer provide benefits by facilitating the performance of the following functions:

- Monitoring, statusing, record transmittal, etc.
- Coordination of operations, activities and ideas.
- Organization through understanding and commonality.
- Control and direction.
- Education.
- Entertainment and intellectual stimulation

The benefit is dependent upon the value obtained through better information transfer provided for fulfillment of functions listed.

Social Benefits

The social benefits are due to human life saved or improvements to personal life and society in general. The rating for social benefit is based upon improving one or more of the following factors:

- Helping to meet basic biological needs such as food, clothing, and saving of life.
- Safety, health, and security (certainty).
- Freedom, fairness, and justice.
- Prestige, distinction, good will.
- Entertainment, mental stimulation, enjoyment of life.
- Cultural advantages, achievements, and intellectual stimulation.
- Increased spheres of interest, awareness and enrichment of life.

Rating	Criteria
5	Prime benefit to most members of society.
4	Acknowledged or prominent benefit to most members of society.
3	Significant benefit to a major segment of society.
2	Slight benefit to society or significant benefit to small sector of society.
1	Slight benefits to only a small sector of society.

For purpose of analysis and rating, social benefits are equated to the following criteria of savings in human life.

5	Greater than 1000 per year.
4	100 to 1000 per year.
3	10 to 100 per year.
2	1 to 10 per year
1	0

Economic Benefits

The economic benefits are due to estimated savings, increase in service worth or value in dollars per year accrued through utilization of better information transfer services.

5	Over 5 billion dollars per year.
4	.5 to 5 billion
3	50 to 500 million
2	5 to 50 million
1	0 to 5 million

Scientific Benefits

The criteria for the rating of scientific benefits are as follows:

Rating	Criteria
5	Directly advances scientific knowledge and understanding, promotes research and scientific education.
4	Directly aids scientific research, education and advancement of sciences.
3	Facilitates knowledge and competence in science and technology.
2	Aids in disseminating knowledge and understanding of sciences.
1	No significant aid to science.

Ranking of Demands

Table 5 presents the unweighted potential benefit rating for each of the 134 screened demands. For convenience they have been grouped by Demand Category. The maximum rank obtainable for any demand is 45 and the lowest is 9. These ranks were used directly along with the Service Implementation Rankings, to be discussed in the following section, to make the final selection of most promising demands.

It should be pointed out that in the preliminary ranking by Demand Category a weighting was given to seven of the nine parameters, based on an estimate of relative importance. To parameters 1 and 7 was applied a weighting factor of 4 and parameters 3, 5, 6, 8 and 9 were weighted by a factor of 2. Parameters 2 and 4 remained unweighted. The ten (10) top or highest ranking Demand Categories remained unchanged as the result of this weighing factor. The results of this analysis were documented earlier in the study.

AMENABLE SERVICE RANKING

Objectives

The objective of this ranking is to rate each demand in accordance with its amenability to service implementation where amenability means to exhibit characteristics which require advancement beyond the nominal projection of conventional terrestial services.

Methodology

The rationale used to determine a demand's amenability to service implementation was based on the following three general factors.

- Status of present service — would it encourage the implementation of a new service?

Table 5

NATIONAL BENEFIT RANKINGS

DEMAND No.	CATEGORY/DEMAND Title	Trend Rate (1)	Technical Availability (2)	Ease of Implementation (3)	Social Acceptance (4)	No. of Users (5)	Beneficiarie (6)	Benefits - Social (7)	Benefits - Economic (8)	Benefits - Scientific (9)	Rank
	1. SPACE PROGRAMS										
080	Weather Satellite Relay	4	4	4	5	3	5	5	3	5	38
1,3	Earth Resources Sat.	4	4	4	5	3	5	5	3	5	38
175	Manned Orbit Support	4	4	4	4	3	5	4	3	4	34
176	Astronomy Data Relay	4	4	4	4	2	5	4	2	5	34
177	Deep Space Relay	4	3	4	4	2	5	4	2	4	32
178	Orbit Computer Facility	4	3	2	4	2	5	3	2	3	28
179	Satellite Control Relay	4	3	4	4	2	5	3	3	4	33
181	Assist On Orbit Assembly	4	3	4	4	2	5	3	3	4	32
182	Flight Performance Testing	4	4	4	4	2	5	4	3	5	35
	2. WEATHER DATA RELAY										
078	Weather Balloon Relay	4	4	5	5	3	5	5	3	5	39
079	Weather Buoy Data Relay	4	4	5	5	3	5	5	3	5	39
081	Weather Station Data Rel.	4	5	4	4	3	5	5	3	5	38
063	Weather, Ocean. D ta Ships	4	4	4	5	3	5	5	3	5	38
084	Relay Weather Forecasts	4	5	4	3	3	5	5	3	4	36
	3. OCEANOGRAPHIC DATA										
105	Ocean Fishing Data	4	3	3	5	2	4	4	2	3	30
106	Ship Routing Data	4	4	2	4	2	4	4	2	3	29
107	Sea State, Ocean Data	4	4	4	5	2	4	5	2	4	33
108	Data from Buoys & Ships, etc.	4	4	5	5	2	4	4	2	5	28
162	Migration Data-Fish, etc.	4	4	2	5	2	4	4	2	5	32
	4. EARTH SCIENCES DATA RELAY										
147	Crop Surveillance, Soil Conservation	4	4	5	5	3	5	5	2	4	37
148	Geology, Topography	4	4	5	5	1	3	2	2	5	31
150	Precision Surveying	4	4	4	5	1	1	2	1	3	25
152	Hydrology, Streams, etc.	4	4	5	5	1	4	3	1	5	32
163	Migratory Animals	4	4	5	5	1	4	3	1	5	32
164	Migratory Birds	4	3	2	5	1	4	3	1	5	28

Table 5 (Continued)

DEMAND No.	CATEGORY/DEMAND Title	Trend Rate (1)	Technical Availability (2)	Ease of Implementation (3)	Social Acceptance (4)	No. of Users (5)	Beneficiarie (6)	Benefits – Social (7)	Benefits – Economic (8)	Benefits – Scientific (9)	Rank
	4. EARTH SCIENCES DATA RELAY (Cont'd)										
239	Earthquake Monitoring	4	5	3	5	1	1	2	1	5	27
	5. AIRCRAFT										
050	Communications, Commercial	5	4	5	5	4	4	4	3	1	35
051	Communications, Private	5	4	3	5	3	3	3	1	1	28
086	Enroute ATC, Commercial	5	4	5	5	4	4	4	3	3	37
037	Enroute ATC, Private	5	3	3	5	3	3	3	2	3	30
068	Collision Avoidance	5	4	5	5	4	4	5	3	1	35
113	Performance, Monitoring	5	4	5	5	4	4	5	2	3	37
130	Scheduling & Statusing	5	4	4	5	4	4	3	2	1	32
052	Passenger Telephone	5	5	4	5	4	4	3	2	1	33
	6. MARINE										
090	Communications, Commercial, Ships	3	4	4	5	2	3	4	2	1	28
091	Communications, Private, Ships	3	4	2	5	2	2	4	3	4	25
092	Communications, Govt., Ships	3	4	5	1	2	2	4	3	4	29
095	Position, Commercial	3	5	4	5	2	2	5	2	1	28
096	Position, Private	4	4	2	5	2	2	4	2	1	26
097	Position, Government	3	4	5	1	2	2	5	1	4	26
098	Collision Avoidance	3	4	4	3	3	3	5	2	1	28
131	Sched. & Statusing Ships	3	4	5	5	2	2	4	2	1	28
	7. RESCUE										
053	Air Sea Rescue	4	4	4	5	2	3	5	3	1	31
	8. GROUND TRAFFIC										
054	Mobile Grd. Communications	3	1	1	5	3	3	2	1	1	20
132	Train Communications	3	2	2	3	1	1	2	1	1	16
134	Bus Communications	3	1	1	5	1	1	2	1	1	16
187	City Traffic Control	3	1	1	4	4	4	2	1	1	21
188	Highway Traffic Control	3	1	1	4	4	4	2	1	1	21
235	Truck Com. Statusing	3	1	1	5	2	2	2	1	1	18

63

Table 5 (Continued)

DEMAND No.	CATEGORY/DEMAND Title	1 Trend Rate	2 Technical Availability	3 Ease of Implementation	4 Social Acceptance	5 No. of Users	6 Beneficiarie	7 Benefits - Social	8 Benefits - Economic	9 Benefits - Scientific	Rank
9.	**STATUSING GOODS, SERVICES**										
133	Sched. and Statusing of Hotels	5	5	5	5	4	4	3	1	1	33
134	Inv. Control & Monitoring	4	5	5	5	2	5	3	4	2	35
250	Commercial Purch. Information	4	5	5	5	2	3	3	3	1	31
10.	**COMPUTER SERVICES**										
164	Time Share Services, etc.	5	5	5	5	4	4	4	4	4	40
246	Automated Design Drafting	5	4	4	5	2	2	2	2	3	29
247	Automated Legal Advice	4	4	5	2	2	2	2	1	3	25
248	Family Management Advice	5	3	3	4	4	4	3	3	2	31
249	Reservations, Schedules	4	4	5	5	4	4	2	2	1	31
255	Home Information Center	5	5	5	5	4	4	3	1	2	34
11.	**PT TO PT TELECOMMUNICATIONS**										
042	Voice Telephone	3	5	4	3	5	5	5	4	2	36
043	Video Phone	3	3	2	3	5	5	4	2	2	29
12.	**TELECONFERENCING**										
114	United Nations	2	5	4	4	5	5	5	3	2	35
115	Conventions	5	5	5	5	3	3	3	3	2	34
117	Business	5	5	5	5	3	3	3	3	2	34
118	Hot Lines	5	5	5	5	1	1	1	1	1	33
120	Legislative Sessions	4	4	5	5	3	5	5	3	2	37
122	Political Presentations	4	4	5	5	4	5	5	3	1	37
123	Stockholder	3	3	5	5	4	4	3	2	1	32
124	Union	2	4	5	5	4	5	3	3	1	32
129	Scientific & Tehnical Societies	4	4	5	5	4	5	3	3	4	38
240	Mental Therapy Groups	4	5	3	4	1	1	2	2	2	24
13.	**NEWS, BROADCAST DISTRIBUTION**										
045	News Service	2	5	5	5	1	1	2	2	1	24
241	TV and Radio Proj. Distribution	2	5	5	5	1	1	1	1	1	22

Table 5 (Continued)

DEMAND No.	CATEGORY/DEMAND Title	Trend Rate (1)	Technical Availability (2)	Ease of Implementation (3)	Social Acceptance (4)	No. of Users (5)	Beneficiarie (6)	Benefits - Social (7)	Benefits - Economic (8)	Benefits - Scientific (9)	Rank
	14. ELECTRONIC PUBLISHING										
048	Facsimile Publishing	3	4	2	3	4	4	4	4	2	30
202	Tape and Video Publishing	4	4	3	4	4	4	4	4	3	34
	15. LANGUAGE TRANSLATION										
145	Automated Audio Translation	2	1	1	5	2	2	2	3	2	20
233	Automated Graphic Translation	2	3	2	5	2	2	2	3	2	23
	16. COMMERCIAL BROADCAST										
110	Television	3	3	2	3	5	5	3	3	2	29
111	Radio	3	5	3	3	5	5	3	3	2	32
	17. CULTURAL PROGRAMS										
159	International Exchange	4	3	2	2	3	4	4	4	4	30
	18. CULTURAL PROGRAMS										
101	Domestic, Museums, Galleries, Historic Events	4	3	2	2	3	3	3	3	4	27
231	Electronic Travel	4	3	2	2	2	2	2	3	2	22
	19. EDUCATION										
006	Pre-school	5	5	5	5	4	5	4	4	1	38
007	Grade School	5	5	5	4	4	5	4	5	2	38
008	High School	4	5	4	3	4	5	3	4	3	36
009	College	5	5	3	3	4	5	3	3	4	34
010	Post Graduate	5	5	3	3	4	5	2	3	5	34
011	Adult Education	5	5	4	3	4	5	3	3	3	38
012	Developing Nations	4	5	4	5	4	5	3	3	3	39
013	Criminal Rehabilitation	5	5	4	5	3	5	4	3	2	36
014	Police Training	4	4	3	5	2	5	2	4	3	34
016	Ailing at Home	5	5	4	5	3	4	4	3	3	37
017	Rural Communities	5	5	4	5	3	5	3	3	1	36
018	Disadvantaged Children	5	4	5	3	3	4	3	4	1	33
0.3	Welfare Recipients	5	4	3	3	3	4	3	3	1	30

65

Table 5 (Continued)

DEMAND No.	CATEGORY/DEMAND Title	1 Trend Rate	2 Technical Availability	3 Ease of Implementation	4 Social Acceptance	5 No. of Users	6 Beneficiarie	7 Benefits - Social	8 Benefits - Economic	9 Benefits - Scientific	Rank
	20. LIBRARY SERVICES										
058	Public	3	5	2	3	4	4	4	2	3	30
060	Special (Technical)	4	5	4	4	3	3	4	4	5	36
061	Colleges, Universities	4	5	4	4	4	4	4	3	4	36
062	Public School	3	4	1	2	4	4	2	2	3	27
063	Patent	3	5	4	4	3	3	4	3	5	32
232	Home Extension	3	5	1	2	4	4	4	2	3	28
	21. WELFARE ADMINISTRATION										
067	Employment Records, Placement	4	5	3	5	4	5	5	4	3	38
068	Social Security	4	5	3	5	5	5	4	3	1	35
069	Housing	3	5	3	5	3	3	3	2	1	28
070	Land Renewal & Util.	3	5	3	5	2	2	2	1	1	24
	22. HEALTH & MEDICAL DATA										
028	Blood, Eye, Organ Banks	3	5	5	5	2	3	4	1	1	29
029	Hospital Admin. Records	3	5	5	5	2	3	4	2	2	31
030	Personal Med. Records	3	5	3	3	5	5	5	2	5	36
032	Diagnostic	3	4	3	3	2	3	5	2	4	39
230	Medical, Home Diagnostic Monitoring	3	3	2	5	2	2	3	2	1	23
	23. LAW ENFORCEMENT										
001	Identification	4	3	4	5	2	5	5	5	1	32
002	Record Transmittal	4	5	4	5	2	5	5	3	1	34
227	Probation Monitoring	4	5	4	5	2	5	5	2	1	33
228	Release on Recognizance	4	5	4	5	2	5	5	3	1	34
	24. ELECTRONIC MAIL										
027	Mail	3	5	5	4	2	5	5	2	1	32
256	Home Teletype Mail	3	4	4	4	2	5	5	3	1	34

Table 5 (Continued)

DEMAND No.	CATEGORY/DEMAND Title	Trend Rate (1)	Technical Availability (2)	Ease of Implementation (3)	Social Acceptance (4)	No. of Users (5)	Beneficiarie (6)	Benefits - Social (7)	Benefits - Economic (8)	Benefits - Scientific (9)	Rank
	25. GOVERNMENT AUDITING										
099	Internal Revenue, Personal	3	5	4	4	5	5	3	2	1	32
100	Internal Revenue, Corp.	3	5	4	5	3	3	2	2	1	28
101	Federal Excise Txes	3	5	4	5	3	3	2	2	1	28
102	Duties	3	5	3	3	3	3	2	2	1	25
103	State Revenues	3	5	3	4	5	5	3	1	1	30
104	Treasury & General Accounting	3	5	4	5	2	2	2	1	1	25
259	Rulings & Regulations	3	5	3	5	3	3	2	1	1	26
	26. BANKING & FINANCE										
036	Electronic Check Handling	4	4	5	5	4	4	3	3	1	33
037	Electronic Credit Caed Trans.	4	5	5	5	4	4	4	3	1	35
040	Identification	4	4	3	5	4	4	5	5	1	35
041	Value & Accounting Network	4	5	4	3	4	4	4	3	1	32
	27. SECURITIES										
074	Transactions	3	5	4	5	4	5	3	2	1	31
075	Quotations	3	5	4	5	4	5	3	2	1	31
	28. CIVIL DEFENSE										
153	Emergency Warning	3	5	2	4	5	5	5	1	1	31
154	Emergency Communications	3	5	2	4	3	5	5	1	1	29
	29. AMATEUR RADIO										
237	Amateur Radio Relay	2	5	5	5	2	2	2	1	2	26
	30. RELIGION										
238	Religious Communications	3	5	4	5	4	4	3	3	1	32
	31. JUDICIAL										
168	Judicial Actions, Proceedings	3	5	3	1	1	5	4	1	1	24
	32. TIME SIGNALS										
157	Time Signals	4	5	4	5	2	3	1	2	5	31

- Economic cons.derations – is it unattractive to commercial interests?
- Service Characteristics – would it then suggest satellite dominance over a conventional system?

It is seen from these three general service factors that a demand that is amenable to service would have the unique characteristics of either replacing a service that is not satisfactory, or of providing a new service; its service would most likely be government sponsored; and it would best be accomplished by a satellite system.

To implement the above rationale, the above service factors were put into the form of questions and were used as criteria to evaluate each demand. A "yes" answer to the following questions would indicate compliance with the rationale.

Status of Present Service:

1. Is the present service inadequate?
2. Is the present service inconvenient?
3. Is the present service not available?

Economic Factors:

1. Are the operational costs a limiting factor?
2. Are excessive development costs limiting?
3. Does the service lack profit incentive?

Satellite Dominance:

1. Are long distances involved?
2. Does a large area have to be covered?
3. Are remote areas involved?
4. Are mobile users involved?
5. Is service flexibility involved?

Analysis and Evaluation

The evaluation was conducted on a modified basis of the Delphi technique. Each demand (134) was tested against the eleven questions by a panel of three analysts. Since weighting or degree of compliance to a given question was not a consideration, each answer given was provided on a yes or no basis. Yes answers to a majority of the above eleven questions would imply that the demand is more amenable to service implementation (study definition) than one that had a majority of no answers. Table 6 shows the result of the evaluation which lists those demands by category and the number of yes answers to the above eleven questions. On the basis of this evaluation, a rank was given to each demand and is shown in the last column of the table. Each rank included more than one demand and can be summarized as follows:

Rank	No. of Demands	No. of Yeses
1	2	11
2	14	10
3	5	9
4	36	8
5	30	7

Table 6

AMENABLE SERVICE RANK

DEMAND No.	CATEGORY/DEMAND Title	1. Lack of Avail. Service	2. Service In-adequate	3. Service In-convenient	4. Operational Cost limits	5. Excess Costs limits	6. Lack of Profit Incentive	7. Long Distances Involved	8. Large Area Coverage	9. Remote Areas	10. Mobile Uses	11. Service Flexibility	Rank
	1. SPACE PROGRAMS (9 Demands)												
080	Weather Satellites	-	1	1	1	1	1	1	1	1	1	1	8
173	Earth Resources Satellites	-	1	1	1	1	1	1	1	1	1	1	10
175	Manned Orbit Support	-	1	1	1	1	1	1	1	1	1	1	10
176	Astronomy	-	1	1	1	1	1	1	1	1	1	1	10
177	Deep Space	-	1	1	1	1	1	1	1	1	1	1	10
178	Computer Facility	-	1	1	1	1	1	1	1	1	1	1	10
179	Satellite Control	-	1	1	1	1	1	1	1	1	1	1	10
181	Assembly on Orbit	-	1	1	1	1	1	1	1	1	1	1	10
182	Performance Testing	-	1	1	1	1	1	1	1	1	1	1	10
	2. WEATHER DATA (5)												
078	Weather, Balloon	-	1	1	1	1	1	1	1	1	1	1	8
079	Weather, Buoys	-	1	1	1	1	1	1	1	1	1	1	8
081	Weather, Stations	-	1	1	-	-	-	1	1	1	-	-	6
083	Weather, Oceanograph, Ship & Floating Stations	-	1	1	-	-	1	1	1	1	1	1	8
084	Weather Forecasting	1	1	1	-	-	1	1	1	-	1	-	5
	3. OCEANOGRAPHIC DATA (5)												
105	Oceanographic Fishing	1	1	1	1	1	-	1	1	1	1	1	10
106	Ship Routing	1	1	1	1	1	-	1	1	1	1	1	8
107	Sea State	1	1	1	1	1	-	1	1	1	1	1	7
108	Resources	1	1	1	1	1	-	1	1	1	1	1	9
162	Migrating Fish	1	1	1	1	1	1	1	1	1	1	1	10
	4. EARTH SCIENCES (7)												
147	Crop Surveillance & Soil Conserv.	-	1	1	1	1	-	1	1	1	1	-	7
148	Geology/Topography	-	1	1	1	1	-	1	1	1	1	-	7
150	Geological Precision Surveying	-	1	1	1	1	-	1	1	1	1	1	6
152	Hydrology, Stream Cond., Erosion	1	1	1	1	1	1	1	1	1	1	1	8
163	Migratory Animals	1	1	1	1	1	-	1	1	1	1	-	10

69

Table 6 (Continued)

DEMAND No.	CATEGORY/DEMAND Title	1. Lack of Avail. Service	2. Service In-adequate	3. Service In-convenient	4. Operational Cost Limits	5. Excess Costs Limits	6. Lack of Profit Incentive	7. Long Distances Involved	8. Large Area Coverage	9. Remote Areas	10. Mobile Uses	11. Service Flexibility	Rank
	4. EARTH SCIENCES (Cont'd)												
164	Migratory Birds	1	1	1	1	1	1	1	1	1	1	–	10
239	Earthquake Monitoring	–	1	1	1	1	1	1	1	1	–	–	8
	5. AIRCRAFT (8)												
050	Aircraft Comm., Commercial	–	1	1	1	1	–	1	1	1	1	–	6
051	Aircraft Comm., Private	–	1	1	–	1	1	1	1	1	1	–	8
086	Enroute A/C, Commercial	–	1	1	1	1	1	1	1	1	1	1	10
087	Enroute A/C, Private	–	1	1	1	1	1	1	1	1	1	1	7
088	Enroute A/C, Collision Avoid.	1	1	1	1	1	1	1	1	1	1	–	9
113	Enroute A/C Performance	–	1	1	1	1	1	1	1	1	1	1	7
130	Scheduling & Status	–	1	1	–	1	1	1	1	1	1	–	7
052	Passenger Telephone	–	–	1	1	1	–	1	1	1	1	1	7
	6. MARINE (8)												
090	Communications, Commercial	–	1	1	1	–	–	1	1	1	1	–	6
091	Communications, Private	–	1	1	–	–	1	1	1	1	1	–	7
092	Communications, Government	–	1	1	1	–	1	1	1	1	1	–	6
095	Ship Position, Commercial	–	1	1	1	–	1	1	1	1	1	–	6
096	Ship Position, Private	–	1	1	1	–	1	1	1	1	1	–	7
097	Ship Position, Government	–	1	1	1	–	1	1	1	1	1	–	7
098	Ship Position, Collision Avoid.	1	1	1	1	1	1	1	1	1	1	1	9
131	Scheduling & Statusing of Ships	–	–	1	1	–	–	1	1	1	1	–	3
	7. RESCUE (1)												
053	A/C Air-Sea Rescue, Emerg. Comm.	–	1	1	–	–	–	1	1	1	1	1	8
	8. GROUND TRAFFIC (6)												
054	Mobile Grd. Communications	–	1	–	1	1	–	–	1	1	1	–	2
132	Scheduling & Statusing of Trains	–	1	1	1	–	–	1	1	1	–	–	3
134	Scheduling & Statusing of Buses	–	–	1	1	1	–	1	1	1	1	–	5
187	Grd. Traffic Control, City	–	1	1	1	1	1	1	1	1	1	–	6

Table 6 (Continued)

DEMAND No.	Title (CATEGORY/DEMAND)	1 Lack of Avail. Service	2 Service In-adequate	3 Service In-convenient	4 Operational Cost Limits	5 Excess Costs Limits	6 Lack of Profit Incentive	7 Long Distances Involved	8 Large Area Coverage	9 Remote Areas	10 Mobile Uses	11 Service Flexibility	Rank
	8. GROUND TRAFFIC (Cont'd)												
188	Grd. Traffic Cont., Highway	–	1	1	1	1	1	–	–	–	1	–	6
236	Sched. & Statusing of Trucks	–	1	1	1	1	–	1	1	1	1	–	5
	9. STATUSING OF GOODS (3)												
133	Sched.- & Statusing of Hotels	–	1	1	1	1	1	1	1	1	–	–	4
139	Inv. Contl, Monitoring & Statusing of Goods	–	1	1	1	1	1	1	1	1	–	–	7
250	Commercial Purch. Information	–	1	1	1	1	1	1	1	1	–	–	4
	10. COMPUTER SERVICES (6)												
169	Time Share Services	–	1	1	1	1	–	1	1	1	–	–	5
246	Automated Des. and Drafting	1	1	1	1	1	–	1	1	1	–	–	6
247	Auto. Legal Advice	1	1	1	1	1	1	1	1	1	–	–	3
248	Family Management Advice	–	1	1	1	–	1	1	1	1	–	–	6
249	Reservations and Schedules	1	1	1	1	1	1	1	1	1	–	–	3
255	Home Information Center	1	1	1	1	1	1	1	1	1	–	–	5
	11. PT TO PT TELECOMMUNICATIONS (2)												
042	Grd to Grd Telecomm.-Voice	–	1	1	1	–	–	1	1	1	1	1	5
043	Grd to Grd Telecomm.-Videophone	1	1	1	1	1	1	1	1	1	1	–	7
	12. TELECONFERENCING (10)												
114	Meeting, United Nations	–	1	1	1	1	–	1	1	1	–	1	9
115	Meeting, Conv (only societies)	1	1	1	1	–	–	1	1	1	–	–	8
117	Meeting, Business	–	1	1	1	1	–	1	1	1	–	–	7
118	Meeting, Hot Line	1	1	1	1	1	1	1	1	1	–	–	3
120	Meeting, Legislature Debates	1	1	1	1	1	–	1	1	1	–	–	8
122	Meeting, Delegate Presentations	1	1	1	1	1	–	1	1	1	–	–	8
123	Meeting, Stockholder	1	1	1	1	1	–	1	1	1	–	–	9
124	Meeting, Union	1	1	1	1	1	–	1	1	1	–	–	8
129	Meeting, Scientific & Tech.Soc.	–	1	1	1	1	–	1	1	1	–	–	6
240	Mental Therapy Groups	1	1	1	1	1	–	1	1	–	–	–	8

71

Table 6 (Continued)

DEMAND No.	CATEGORY/DEMAND Title	1 Lack of Avail. Service	2 Service In-adequate	3 Service In-convenient	4 Operational Cost limits	5 Excess Costs limits	6 Lack of Profit Incentive	7 Long Distances Involved	8 Large Area Coverage	9 Remote Areas	10 Mobile Uses	11 Service Flexibility	Rank
	13. NEWS, BROADCAST DISTRIBUTION (2)												
045	News Service	-	1	-	-	-	-	1	1	1	1	-	4
241	TV & Radio Prog. Dist.	1	1	-	1	1	-	1	1	1	-	-	7
	14. ELECTRONIC PUBLISHING (2)												
048	Facsimile Production	-	1	1	1	1	-	1	1	-	-	-	2
202	Electronic Publishing	-	1	1	1	1	-	1	1	-	-	1	7
	15. LANGUAGE TRANSLATION (2)												
145	Automated Lang. Translation Audio	1	1	1	1	1	1	1	1	-	-	-	8
233	Graphic Lang. Translation	1	1	1	1	1	1	1	1	-	-	-	8
	16. COMMERCIAL BROADCAST (2)												
110	Entertainment, TV	-	1	1	1	1	1	1	1	1	1	-	6
111	Entertainment, Radio	-	1	-	1	-	-	1	1	1	1	1	4
	17. CULTURAL PROGRAMS-INTERNATIONAL (1)												
159	Cultural Prog., International	-	1	1	1	-	1	1	1	1	-	1	8
	18. CULTURAL PROGRAM-DOMESTIC (2)												
161	Cult. Prog., Museums, Galleries, Historical Events	-	1	-	1	1	1	1	1	1	-	-	7
231	Electronic Travel, Shows, etc.	-	1	1	1	1	-	1	1	1	-	-	7
	19. EDUCATION BROADCASTS AND SVC (13)												
006	Education, Pre-school	-	1	1	1	1	1	1	1	1	-	-	8
007	Education, Grade School	-	1	1	1	1	1	1	1	1	-	-	8
008	Education, High School	-	1	1	1	1	1	1	1	1	-	-	8
009	Education, College	-	1	1	1	1	1	1	1	1	-	-	8
010	Education, Post Graduate	-	1	1	1	1	1	1	1	1	-	-	8
011	Education, Adult	-	1	1	1	1	1	1	1	1	-	-	8
012	Education, Developing Nations	-	1	1	1	1	1	1	1	1	-	-	8
013	Education, Criminal Rehab.	-	1	1	1	1	1	1	1	1	-	-	8
014	Education, Police Training	-	1	1	1	1	1	1	1	1	-	-	8

Table 6 (Continued)

DEMAND No.	CATEGORY/DEMAND Title	1 Lack of Avail. Service	2 Service Inadequate	3 Service Inconvenient	4 Operational Cost Limits	5 Excess Costs Limits	6 Lack of Profit Incentive	7 Long Distances Involved	8 Large Area Coverage	9 Remote Areas	10 Mobile Uses	11 Service Flexibility	Rank
19.	EDUCATION BROADCASTS AND SVC (Contd)												
016	Education, Ailing at Home	-	1	1	1	1	1	1	1	1	0	0	8
017	Education, Rural Communities	-	1	1	1	1	1	1	1	1	-	-	8
018	Education, Disadvantaged	-	1	1	1	1	1	1	1	1	-	-	8
023	Education, Welfare	-	1	1	1	1	1	1	1	1	-	-	8
20.	LIBRARY (6)												
058	Public	-	1	1	-	1	1	1	1	-	-	-	6
060	Special	-	1	1	1	1	1	1	1	-	-	-	7
061	Colleges and Universities	-	1	1	1	1	1	1	1	-	-	-	7
062	Public Schools	-	1	1	1	1	1	1	1	-	-	-	6
063	Patents	-	1	1	1	1	-	1	1	-	-	-	7
232	Home Extension	-	1	1	1	1	1	1	1	1	-	-	8
21.	WELFARE (4)												
067	Employment Records	-	1	1	1	1	1	1	1	1	-	-	8
068	Social Security Administration	-	1	1	1	1	1	1	1	1	-	-	8
069	Housing	-	1	1	1	1	1	1	1	-	-	-	3
070	Land Renewal & Utilization	-	1	1	1	1	1	1	1	-	-	-	3
22.	HEALTH AND MEDICAL DATA (5)												
028	Blood, Eye, Organ, Banks	-	1	1	-	1	1	1	1	-	-	-	3
029	Hospital Records	-	1	1	1	1	1	1	1	-	-	-	4
030	Medical, Health Records	-	1	1	1	1	1	1	1	1	1	-	5
032	Medical, Diagnostic	1	1	1	1	1	1	1	1	1	1	-	11
230	Medical, Home Diag. & Monitoring	-	1	1	1	1	1	1	1	-	1	-	7
23.	LAW ENFORCEMENT (4)												
001	Identification	-	1	1	-	1	1	1	1	1	-	-	7
002	Records	-	1	1	1	1	1	1	1	-	-	-	7
227	Probation Monitoring	-	1	1	1	-	1	1	-	-	-	-	2
228	Released Recognizance	-	1	1	1	-	1	1	-	-	-	-	2

73

Table 6 (Continued)

DEMAND No.	CATEGORY/DEMAND Title	1 Lack of Avail. Service	2 Service Inadequate	3 Service Inconvenient	4 Operational Cost Limits	5 Excess Costs Limits	5 Lack of Profit Incentive	7 Long Distances Involved	8 Large Area Coverage	9 Remote Areas	10 Mobile Uses	11 Service Flexibility	Rank
24.	**ELECTRONIC MAIL (2)**												
027	Mail	–	1	1	1	1	1	1	1	1	–	–	8
256	Home Teletype Mail	–	1	1	1	1	1	1	1	1	–	–	5
25.	**GOVERNMENT AUDITING (7)**												
099	Internal Revenue – Personal	–	1	1	1	1	1	1	1	–	–	–	7
100	Internal Revenue – Corporation	–	1	1	1	1	1	1	1	–	–	–	7
101	Federal Excise Tax	–	1	1	1	1	1	1	1	–	–	–	7
102	Duties	–	1	1	1	1	1	1	1	–	–	–	7
103	State Revenue	–	1	1	1	1	–	1	1	–	–	–	5
104	Int. Rev., Treas. & Gen. Acctg.	–	1	1	1	1	1	1	1	1	–	–	7
259	Rulings and Regulations	–	1	1	–	1	1	1	1	1	–	–	4
26.	**BANKING AND FINANCE (4)**												
036	Banking, Checks	–	1	1	1	1	1	1	1	–	–	–	5
037	Banking, Credit Cards	–	1	1	1	1	1	1	1	–	–	–	4
040	Banking, Realtime Post. Ident.	1	1	1	1	1	1	1	1	:	–	–	7
041	Banking, Services Network	–	1	1	–	1	1	1	1	1	–	–	5
27.	**SECURITIES (2)**												
074	Securities Exch. – Transactions	–	1	1	–	1	1	1	1	–	–	–	4
075	Securities Exch. – Quotations	–	1	1	–	1	1	1	1	–	–	–	4
28.	**CIVIL DEFENSE (2)**												
153	Emergency Warning	1	1	1	1	1	1	1	1	1	1	1	10
154	Emergency Communications	1	1	1	1	1	1	1	1	1	1	1	11
29.	**AMATEUR RADIO (1)**												
237	Amateur Radio	–	1	–	1	1	1	2	1	1	1	1	8
30.	**RELIGION (1)**												
238	Religions	–	1	1	1	1	1	1	1	1	–	–	8
31.	**JUDICIAL (1)**												
168	Court Proceed., Judicial Actions	–	1	1	–	–	1	1	1	–	–	–	5

Table 6 (Continued)

DEMAND		CATEGORY/DEMAND	Lack of Avail. Service	Service In-adequate	Service In-convenient	Operational Cost limits	Excess Costs limits	Lack of Profit Incentive	Long Distances Involved	Large Area Coverage	Remote Areas	Mobile Uses	Service Flexibility	Rank
No.		Title	1	2	3	4	5	6	7	8	9	10	11	
157	32.	TIME SIGNALS (1) Time Signals	-	1	1	-	-	1	1	1	1	1	-	7

Rank	No. of Demands	No. of Yeses
6	14	6
7	12	5
8	9	4
9	8	3
10	4	2

A very coarse selection is possible from the above summary on the arbitrary assumption that if a demand did not warrant at least a median of 8 yeses, it should not be considered further. A selection on this basis would leave the following 57 demands for further consideration:

Rank	Title of Demand	Rank	Title of Demand
1	Medical Diagnostic	4	Library Home Extension
1	Civil Defense Emergency Comm.	4	Employment Records
2	Civil Defense Emergency Warning	4	Social Security Adm.
2	Earth Resources Satellites	4	Automated Language Translator
2	Manned Orbit Support	4	Graphic Language Translator
2	Astronomy – Space	4	Cultural Program Intl.
2	Deep Space Travels	4	Education Preschool
2	Computer Facility	4	Education Grade School
2	Satellite Control	4	Education High School
2	Assembly on Orbit	4	Education College
2	Performance Testing	4	Education Post Graduate
2	Oceanographic Fishing	4	Education Adult
2	Migratory Fish	4	Education Developing Nations
2	Migratory Animals	4	Education Criminal Rehabilitation
2	Migratory Birds	4	Education Police Tracing
2	Enroute ATC Commercial	4	Meetings Convention (Societies)
3	Earth Resources	4	Meetings Legislatures
3	A/C Collision Avoid	4	Meeting Delegate
3	Ship Position Collision Avoid	4	Meeting Unions
3	Meetings U. N.	4	Mental Therapy Groups
3	Stockholders	4	Earth Quake Monitoring
4	Mail	4	A/C Communication Private
4	Amateur Radio	4	A/C Air Sea Rescue
4	Religions	4	Weather Satellites
4	Education Ailing at Home	4	Weather Balloons
4	Education Rural Communities	4	Weather Buoys
4	Education Disadvantaged	4	Weather Ships
4	Education Welfare	4	Ship Routing
4	Hydrology		

Significant Findings

It is apparent this type of evaluation provides a coarse evaluation, since many demands have the same rank. To obtain a finer gradation of demands, it would be necessary to increase the number of questions or evaluation points. It is apparent that those demands that are ranked highest do have the characteristics stated in the rationale. Of particular note are those demands construed to be within the NASA province of space programs.

It is concluded that a further refinement of selecting the most promising demands is required. Combining this evaluation with the benefit evaluation was recommended as the final selection.

SELECTION OF MOST PROMISING DEMANDS

Background

One of the two major objectives of the study was to select, from the broad spectrum of Information Transfer demands which were identified earlier in the study, those demands which were considered to be most promising. The foundation for this activity was laid down in the previously discussed Demand Trend Analysis, the development of Functional Requirements, preliminary screening, ranking, and the background of data in the many information transfer areas which were researched from literature and interviews with experts in the field.

Methodology

The definition in contract terms of "most promising" or "high payoff" was a matter for the study to establish. The basic requirements of the study suggested that "most promising" areas would be those which, first, maintained a relatively high benefit to the United States. A second requirement was for the service implementing the demand to exhibit characteristics which required advancement beyond the normal projection of conventional terrestrial services. The parameters which expressed these requirements were developed for the Benefit and Service Implementation ranking which was previously discussed. A total of twenty parameters were developed. Nine of these evaluated the "benefit" considerations and eleven evaluated the merits for "service implementation." The combination of these parameters was the fundamental method for the selection of the "most promising" demands. The techniques used and their resultant products are discussed in the sequence in which they were finally applied. The evolution of the process from conception to the final results covered a period of approximately two months. The results of preliminary tests and preliminary selections are a matter of record but are not included in this final report.

Plot of Benefit vs. Service Implementation Indices

A first step in the combining of the two rankings was to convert the ranked values to a common base. A zero to 100 index was chosen for convenience. Table 7 presents the conversion for each of the 134 screened demands. The demands have been grouped by demand categories. The value for the rank obtained is from the tabular ranking results previously discussed. The conversion value to a 0 to 100 index scale is shown for "Service Implementation" (column designated "A") and for Benefit (column designated "B"). These demands are identified by their "Demand Master List Number." The plot of these values is shown in Figure 17. Considerable dispersion of the relative position of 134 demands is apparent from the plot. The demand with the highest combined values appears in the upper right area of the plot; the lowest, at the lower left.

The plot was a convenient way to present the relative position of 134 screened demands. It did not, however, provide a means within itself to select a specific quantity of high ranking demands as the most promising.

Table 7

AND INDEX VALUES FOR 134 ITS DEMANDS

Demand Category	Master Demand List Number	Rank A	Rank B	Index A	Index B	Demand Category	Master Demand List Number	Rank A	Rank B	Index A	Index B
1.	080	8	38	73	80	15.	145	8	20	73	30
	173	10	38	91	80			5	23	45	39
	175	10	34	91	69		233	8	23	73	39
	176	10	34	91	69						
	177	10	32	91	64	16.	110	6	29	55	55
	178	10	28	91	53		111	4	32	36	64
	179	10	33	91	67						
	181	10	32	91	64	17.	159	8	30	73	58
	182	10	35	91	72						
2.	078	8	39	73	83	18.	161	7	27	64	50
	079	8	39	73	83		231	7	22	64	36
	081	6	38	55	81						
	083	8	38	73	80	19.	006	8	38	73	80
	084	5	36	45	75		007	8	38	73	80
3.	105	10	30	91	58		008	8	36	73	75
	106	8	29	73	55		009	8	34	73	69
	107	7	33	64	67		010	8	34	73	69
	108	9	28	82	53		011	8	38	73	80
	162	10	32	91	64		012	8	39	73	83
4.	147	7	37	64	78		013	8	36	73	75
	148	7	31	64	61		014	8	34	73	69
	150	6	25	55	44		016	8	37	73	78
	152	8	32	73	64		017	8	36	73	75
	163	10	32	91	64		018	8	33	73	67
	164	10	28	91	53		023	8	30	73	58
	239	8	27	73	50	20.	058	6	30	55	58
5.	050	6	35	55	72		060	7	36	64	75
	051	8	28	73	53		061	7	36	64	75
	052	7	33	64	67		062	6	27	55	50
	087	7	37	64	78		063	7	32	64	64
	086	10	30	91	58		232	8	28	73	53
	088	9	35	82	72						
	113	7	37	64	78	21.	067	8	38	73	80
	130	7	32	64	64		068	8	35	73	72
6.	090	6	28	55	53		069	3	28	27	53
	091	7	25	64	44		070	3	24	27	42
	092	7	29	64	55						
	095	6	28	55	53	22.	028	3	29	27	55
	096	7	26	64	47		029	4	31	36	61
	097	7	26	64	47		030	5	36	45	75
	098	9	28	82	53		032	11	39	100	83
	131	3	28	27	53		230	7	23	64	39
7.	053	8	31	73	61	23.	001	7	32	64	64
8.	054	2	20	18	30		002	7	34	64	69
	132	3	16	27	19		227	2	33	18	67
	134	5	16	45	19		228	2	34	18	70
	187	6	21	55	33						
	188	6	21	55	33	24.	027	8	32	73	64
	236	5	18	45	25		256	5	34	45	69
9.	133	4	33	36	67	25.	099	7	32	64	64
	139	7	35	64	72		100	7	28	64	53
	250	4	31	36	61		101	7	28	64	53
10.	169	5	40	45	86		102	7	25	64	44
	246	6	29	55	55		103	5	30	45	58
	247	3	25	27	44		104	7	25	64	44
	248	6	31	55	61		259	4	26	36	47
	249	3	31	27	61						
	255	5	34	45	69	26.	036	5	33	45	67
11.	042	5	36	45	75		037	4	35	36	72
	043	7	29	64	55		040	7	35	64	72
12.	114	9	35	82	72		041	5	32	45	64
	115	8	34	73	69						
	117	7	34	64	69	27.	074	4	31	36	61
	118	3	33	27	67		075	4	31	36	61
	120	8	37	73	78						
	122	8	37	73	78	28.	153	10	31	91	61
	123	9	32	82	64		154	11	39	100	55
	124	8	32	73	64						
	129	6	38	55	81	29.	237	8	26	73	47
	240	8	24	73	42						
13.	045	4	24	36	42	31.	168	5	24	45	42
	241	7	22	64	36						
						31.	168	5	24	45	42
14.	048	2	30	18	58						
	202	7	34	64	69	32.	157	7	31	64	61
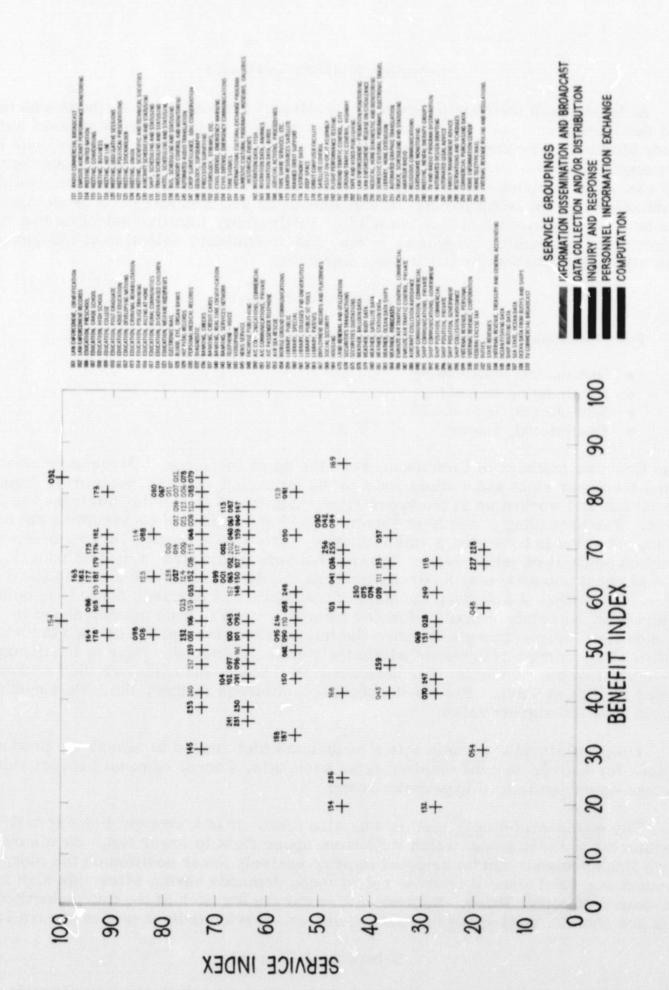
Figure 17 Service Implementation Vs. Benefit Indices

79

Selection Methods and Tests

At least seven methods for selection evolved. Each of these methods was tested and the results analyzed and recorded. Intermediate results were discussed with the Study Monitor. The review of these preliminary results of tests and selections led to firming up four selection methods. These are briefly discussed below, together with the results of applying these methods on a sample number of demands. It should be pointed out that the exact number of demands to be selected was not a predetermined number. It was evolved during the study. Preliminary intuitive selection had limited selection of top ranking categories to ten, and preliminary selection of top demands was also accomplished for the 10 top categories.

Final Selection Methods

Four methods were used in the final selection process. These were:

- Dominance, descending
- Dominance, ascending
- Equilateral, hyperbolic
- Equilateral, linear

The first two methods of Dominance were the same technique. Descending started from the upper right and worked down to the lower left. Ascending started from the lower left and worked up to the upper right. Figure 18 shows the dominance techniques. The ascending example is shown. Ranking is initiated by assigning the demand of lowest value in both axes a value of zero. (See $X_{(0)}$ in Figure 18. X_0 dominates no demand below it on either axis. The two demands designated $X_{(1)}$ dominate X_0 and a line of equal potential may be drawn between the demand and addresses in the coordinate axes. The value of a demand consists of the number of demands below it in both axes. Therefore, a rectangle may be formed from a demand to each axis as shown by the dashed line. The rectangle includes the intersection (zero point) of the axes as indicated. The number of demands within the rectangle gives the value of the demand at the corner of the rectangle. For ascending dominance, demands are then ranked by order of highest value. For the descending dominance method, the lowest number would have the highest value,

The equilateral hyperbola was a technique which tended to assess the product of the values for a given demand obtained from each axis. Curves of equal product value tended to take on an equilateral hyperbolic shape.

The equilateral-linear method was also used. It is a straight line curve drawn perpendicular to the diagonal which runs from upper right to lower left. By a series of such lines demands can be selected in progressively lower position on the plot. This method was used since it tends to select those demands having extremely high values measured on either index. Representative curves for each of the four selection methods are shown superimposed on the Benefit vs. Service Indices plot in Figure 19.

Selection of Demands

Families of curves were superimposed on the plot to select a sample of from 50 to 60 demands ranked by each of the selection methods. The results of this activity are summarized in Table 8. Each selection method is shown identified by Cases I through IV. The rank for a given demand is shown in the appropriate case column. Some cases picked up demands which other cases did not reach. These are shown in the Column "No. of Cases Picked Up."
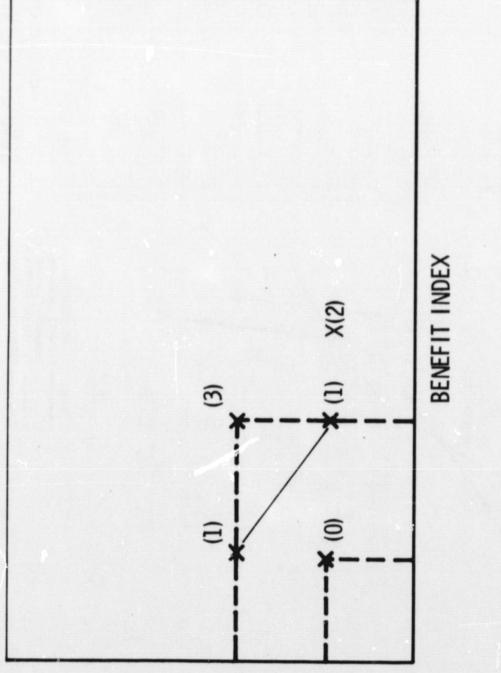
Figure 18 Ascending Dominance Evaluation Method
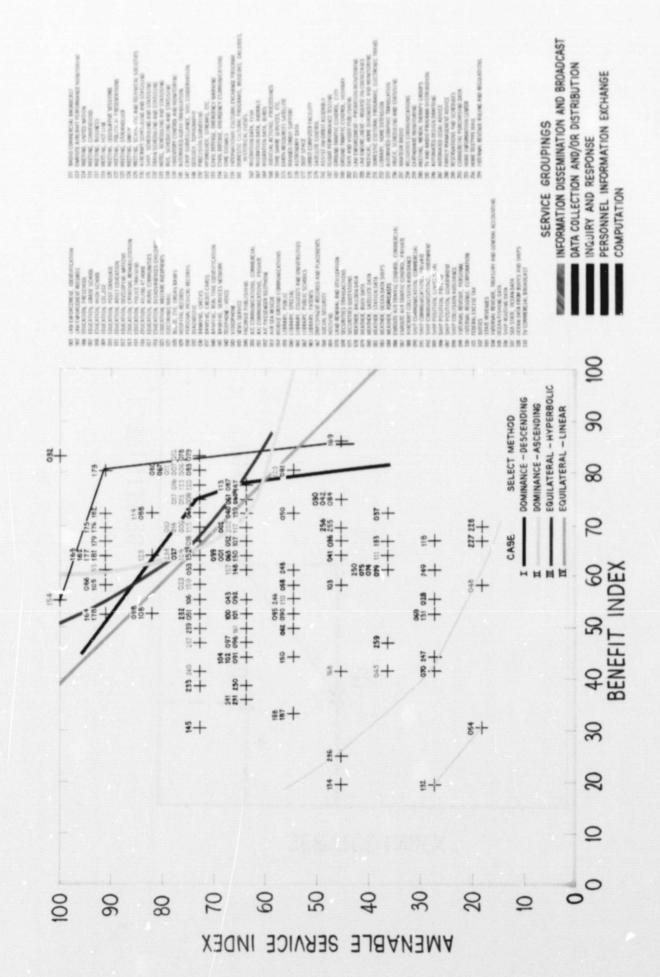
Figure 19 Service Vs. Benefit Indices

Table 8

SUMMARY OF DEMANDS SELECTED IN ORDER OF RANK
BY FOUR SELECTION METHOD

Demand No.	Dominance-Descending Case I	Dominance-Ascending Case II	Equilateral-Hyperbola Case III	Equilateral-Linear Case IV	No. of Cases Picked Up (0 - 4)
032	1	1	1	1	4
169	2	–	–	60	2
154	4	–	29	10	3
173	3	2	2	2	4
012	5	3	6	7	4
078	6	4	7	8	4
079	7	5	8	9	4
182	8	12	3	3	4
175	9	13	4	4	4
176	10	14	5	5	4
179	13	20	9	6	4
162	20	25	18	11	4
163	21	26	19	12	4
177	22	27	20	13	4
181	23	28	21	14	4
088	11	18	10	15	4
114	12	19	11	16	4
006	14	6	12	17	4
007	15	7	13	18	4
011	16	8	14	19	4
067	17	9	15	20	4
080	18	10	16	21	4
083	19	11	17	22	4
153	24	39	25	23	4
016	27	15	22	24	4
120	28	16	23	25	4
122	29	17	24	26	4
086	25	43	31	27	4
105	26	44	32	28	4
008	38	23	26	29	4
013	39	22	27	30	4
017	40	21	28	31	4
123	30	38	33	32	4
068	45	24	30	33	4
164	33	–	42	34	3
178	34	–	43	35	3
009	46	34	34	36	4
010	47	35	35	37	4
115	48	36	37	39	4
087	35	29	39	40	4
113	36	30	40	41	4
147	37	31	41	42	4
018	–	40	38	43	3
060	41	32	–	44	3
061	42	33	–	45	3
027	–	48	44	46	3
124	–	49	45	47	3
152	–	50	46	48	3
238	–	51	47	49	3
040	50	41	48	50	4
139	51	42	49	51	4
081	31	–	–	42	2
129	32	–	–	53	2
098	43	–	51	54	3
108	44	–	52	55	3
053	–	–	50	56	2
002	–	45	–	57	2
117	–	46	–	58	2
202	–	47	–	59	2
014	49	37	36	38	4

Each of the selection methods showed some significant variations in the demands which they selected and in the relative rank of a given demand. Some methods picked up demands with high value on one index scale and low value on another index. Other methods only selected demands with relatively high index values on both axes. In order to give consideration to these differences, all demands which were ranked by any of the four methods were analyzed.

This consisted of both an averaging of ranks and the analysis of the composition of the ranks within the average. For example:

Demand	Cases				Rank Ave.	Final Rank
	I	II	III	IV		
078	6	4	7	8	6	4
182	8	12	3	3	6	5

Demand 078 was ranked higher than 182 even though it had the same average rank. This was because Demand 078 was ranked uniformly higher by the four selection methods.

A list of the top 51 demands which were ranked according to the process just defined is included in Table 9.

An analysis was made of the numbers of the high ranking demands which were selected in relation to their respective Demand Categories. The first 10 ranked demands represented 4 Demand categories. The second 10 ranked demands brought in 6 additional demand categories. The next group of 10 brought in only 1 new category and, one more in the next. Two new categories were brought in by the final column of 10 demands. These 51 demands then were represented by 14 Demand Categories.

Similarly these 51 sample demands were analyzed against the network groups which have been previously defined in this report. Four of the five network groups would be required to implement the 51 demands. Over 40 percent of the demands could be implemented by Network Group II and an almost equal percentage required Network Group I. A much smaller amount utilizes Network Group III. One demand used Group IV, and none of the first 51 Demands ranked. As was previously stated, no magic number of demands were stipulated for the selection process, however, 10 categories were intuitively established in early discussions as being a reasonable sample. A view of all of the preceding ranking methods, and their results, prompted a selection of the first 31 demands as being the most promising.

Analysis of Final Selection

With the selection of the 31 most promising demands, another analysis was made of those selected. Table 10 shows the 31 demands in order of the final ranking process. The columns to the right show the ranking of these same demands by the individual selection methods. It was found from this analysis that 24 of the 31 demands were within the 1-31 final selection group when all of the four methods were used individually. Seven of the final list would have been deleted by at least one of the four individual selection methods. The seven demands are indicated by asterisk (*) in Table 10. Of interest, six of the seven are the lowest ranked of the 31 most promising demands. A discussion of variations between the finally selected 31 demands and individual methods are shown below.

Table 9

51 TOP RANKING DEMANDS

Title	Demand Category	Title	Demand Category
Medical Diagnostic	22	Education, Rural Communities	19
Earth Resources Satellite	1	Enroute Air Traffic Control, Commercial	5
Education, Developing Nations	19	Time Share Services	10
Weather Balloon Data	2	Ocean Fishing Data	3
Flight Performance Testing	1	Social Security	21
Weather Buoy Data	2	Meeting Stockholder	12
Manned Orbit Support	1	Enroute Air Traffic Control, Private	5
Astronomy Data	1	Enroute Aircraft Performance Monitoring	5
Satellite Control	1	Migration Data, Birds	4
Education, Pre-school	19	Crop Surveillance, Soil Conservation	4
Aircraft Collision Avoidance	5	Ranking, Real Time Identification	26
Education, Grade School	19	Education, College	19
Education, Adult Education	19	Orbit Computer Facility	1
Civil Defense, Emergency Communications	28	Education, Post Graduate	19
Meeting, United Nations	12	Library, Special	20
Employment Records and Placement	21	Education, Police Training	19
Weather Satellite Data	1	Meeting, Conventions	12
Weather Ocean Data Ships	2	Library, College and Universities	20
Migration Data, Fish	3	Education, Disadvantaged Children	19
Migration Data, Animals	4	Weather Station Data	2
Deep Space	1	Meeting, Scientific and Technical Societies	12
Assist on Orbit Assembly	1	Electronic Mail	24
Education, Ailing at Home	19	Meeting, Union	12
Meeting, Legislative Sessions	12		
Meeting, Political Presentations	12		
Civil Defense, Emergency Warning	28		
Education, High School	19		
Education, Criminal Rehabilitation	19		

Table 10

COMPARISON OF SELECTION METHODS

Title	Dominance Descend	Dominance Ascend	Equilateral Hyperbola	Equilateral Linear
Relay of Medical Diagnostic Data & Consulting Services	1	1	1	1
Relay of Earth Resources Satellite Data	3	2	2	2
Education, Programs for Developing Nations	5	3	6	7
Relay of Weather Balloon Data	6	4	7	8
Orbit Flight Testing Flight Performance	8	12	3	3
Relay of Weather Buoy Data	7	5	8	9
Relay of Support Data for Man In Orbit	9	13	4	4
Relay of Astronomy Data From Satellite	10	14	5	5
Relay of Satellite Control Data	13	20	9	6
Education, Programs for Pre-school Students	14	6	12	17
Aircraft Collision Avoidance Data	11	18	10	15
Education, Programs for Grade School Students	15	7	13	18
Education, Programs for Adult Students	16	8	14	19
*Civil Defense, Emergency Communications	4	–	29	10
United Nations Teleconferencing	12	19	11	16
Centralization; Relaying of Employment Records	17	9	15	20
Relay of Weather Satellite Data	18	10	16	21
Relay of Weather Ships Data	19	11	17	22
Relay of Tracking Data for Determining Fish Migration Patterns	20	25	18	11
Relay of Tracking Data for Determining Animal Migration Patterns	21	26	19	12
Relay of Deep Space Exploration Data	22	27	20	13
Relay of Orbit Assembly Data	23	28	21	14
Education, Programs for Ailing at Home	27	15	22	24
Legislative Teleconferencing	28	16	23	25
Political Teleconferencing	29	17	24	26
*Civil Defense, Emergency Warning Data Transmissions	24	39	25	23
*Education, Program for High School Students	38	23	26	29
*Education, Programs for Criminal Rehabilitation	39	22	27	30
*Education, Programs for Rural Communities	40	21	28	31
*Enroute Air Traffic Control, Commercial	25	43	31	27
*Computational Information Services	2	0	0	60

The dominance descending method picked 28 of 31 most promising demands, but not necessarily in the same order of rank. That is, 28 of the demands finally selected were ranked between the values of 1 to 31 by the dominance descending method. The three demands in variance (deleted) were:

No.	Title
008	Education, High School
013	Education, Criminal Rehabilitation
017	Education, Rural Communities

The demand which would have been substituted for the above 3 by dominance descending method alone were:

No.	Title
105	Ocean Fishing Data
125	Meeting Stockholder
081	Weather Station Data

The dominance ascending method picked 27 of the 31 most promising demands. The four demands in variance (deleted) were:

No.	Title
153	Civil Defense, Emergency Warning
154	Civil Defense, Emergency Communications
086	Enroute Air Traffic Control, Commercial
169	Time Share Services

The new demands which would have been substituted for the above four by the dominance ascending method alone were:

No.	Title
068	Social Security
087	Enroute Air Traffic Control, Private
113	Enroute Air Traffic Control, Performance Monitoring
147	Crop, Surveillance, Soil Conservation

The equilateral hyperbola method selected thirty of the 31 demands. The one demand in variance (deleted) was Demand No. 169 "Time Share Services." In its place, this method would have substituted Demand 068, "Social Security."

The equilateral — linear method picked 30 of the 31 demands. The demand in variance (deletion) was the same as the previous method — No. 169. In its place, this method substituted Demand 105 "Ocean Fishing Data."

In summary, the four methods show up nine variations. However, three of the methods picked the same Demand (No. 169) for deletion. The net result is seven different demands in variation. The major effect by substituting any one selection method would have been by the use of dominance ascending alone in the final selection, in which case category No. 28 — Civil Defense, and No. 10 — Computer Services, would have been deleted. No new categories would have been added. This selection would have also eliminated the need for the Computation Network.

Refined Operational and Economic Analysis

There was much iteration during the course of the study among the five basic tasks of the ITS Requirement Study. In order to look at the "whole" picture of Information Transfer, many separate activities were repeatedly accomplished in Demand Trends, Functional Requirements, and in compiling Demand Profiles for Demand Categories. However, the final fix for this refinement was established with the final selection of the 31 most promising demands.

STUDY RESULTS

Background

The principal outputs of the study were the selection — from a broad spectrum of demands for transfer of information — those demands which were considered by the study to be most promising, (see Table 10) and a set of functional requirements for these selected demands for the 1970, 1975, and 1985 time frames (see Tables 11, 12, and 13 in following pages). The definition in contract terms of "most promising" or "high payoff," as established by the study, was those services which would first; maintain a relatively high benefit to the U.S. and, second, exhibit characteristics which required advancement beyond the normal projection of conventional terrestrial services.

The selected demands are shown in the following Tables 11, 12, and 13, with their functional requirements in summary form for the three time frames of 1970, 1975, and 1985. Each demand is categorized by a particular network category (as discussed earlier) and in order of importance. The functional requirements were established to define those characteristics considered to be most significant in regard to further study of a design concept. These tables contain additional data that were not provided in the basic functional matrices shown earlier, although the data were derived from those basic charts. A description of these additional data follows.

Throughout the study, the transfer of information was considered to be one of three types, video, voice, or digital. In the time frame of 1970 and 1975, teletype and analog were also considered but within this study they were treated as a form of digital data. In a majority of the demands for information transfer services, voice was required in conjunction with video, in these cases, voice was not identified separately. Where voice was used as the only means of information transfer — that is, without video it was then identified separately (voice*). The quantity of information (voice or video) transferred is also provided, with an indication of what time within a 24 hour period the transfer will take place. The first, quantity of data, is shown as channel hours per year and is an average estimate of the amount of information transferred per year in order to satisfy the demands. The one year time base was considered necessary since some demands had message spacings of weeks' or months, making it difficult to use smaller time units then one year. The number of channels required was based on individual demand estimates of message spacing and duration as already described earlier. The time period that the peak transfer of information will likely occur is represented by the following time blocks:

Block	Period of Day
1	0000-0600
2	0600-1200
3	1200-1800
4	1800-2400

88

Table 11

SUMMARY OF ITS FUNCTIONAL REQUIREMENTS – 1970

Service and Demand Title (No. of Users, Terminals, Mission, etc.	Types and Quantity of Information				Message Characteristics			
	Voice and Video (Or Voice Only* – Video Only**)			Digital	Quality	Reliability	Privacy	Priority
	Number of Channels	Channel-Hours Per Year	Time Blocks (1,2,3,4)	Bits Per Year				
I. INFORMATION DISSEMINATION AND BROADCAST NETWORK								
Education, Developing Nations (5 x 10^3 Terminals)	10	40 x 10^3	2, 3, 4	–	37 DB	Med	Med	Med
Education, Preschool (18 x 10^6 People)	1	250	2	–	37 DB	Med	Med	Med
Education, Grade School (37 x 10^6 People)	1	36	2	–	37 DB	Med	Med	Med
Education, Adult (134 x 10^6 People)	1	242	2	–	37 DB	Med	Med	Med
Civil Defense, Emergency Communications (200 x 10^6 People)	–	–	–	44 x 10^6 (Teletype)	10^{-2}	High	Low	Top
Civil Defense, Emergency Communications (200 x 10^6 People)	1*	122*	1, 2, 3, 4	–	30 DB	High	Low	Top
Elec. Meetings, United Nations (174 Members)	1*	3200*	2, 3, 4	–	30 DB	Med	High	Med
Education, Ailing at Home (30 x 10^4 People)	1	365	2, 3	–	37 DB	Med	Med	Med
Meetings, Legislators (1100 Legislators)	2	44 x 10^5	2, 3	–	30 DB	Med	High	Med
Meeting, Political (30 x 10^3 Members)	40*	8 x 10^4*	2, 3	–	20 DB	Med	High	Med
Civil Defense, Emergency Warning (200 x 10^6 People)	1*	121*	1, 2, 3, 4	–	20 DB	High	Low	Top
Civil Defense, Emergency Warning (200 x 10^6 People)	–	–	–	44 x 10^6 (Teletype)	10^{-2}	High	Low	Top
Education, High School (15 x 10^6 Students)	1	52	3	–	37 DB	Med	Med	Med
Education, Criminal Rehab (300 x 10^3 People)	1	52	4	–	37 DB	Med	Med	Med
Education, Rural Community (13 5 x 10^6 People)	See Education – Criminal Rehabilitation, High School, Adult, and Grade School Demands							
II. DATA COLLECTION AND DISTRIBUTION NETWORK								
Earth Resources Satellite (1 Satellite)	1**	6000	1, 2, 3, 4	–	37 DB	High	High	High
Earth Resources Satellite (1 Satellite)	–	–	–	21.6 x 10^9	10^{-5}	High	High	Top
Weather Balloon Data (16 Balloons)	–	–	–	14.6 x 10^{10}	10^{-4}	Med	Low	Med
Orbit-Flight Testing (3 Tests)	–	–	–	79 x 10^7	10^{-4}	High	Med	High
Weather Buoy Data (50 Buoys)	–	–	–	73 x 10^8	10^{-4}	Med	Low	Med
Manned Orbit Support (3 Missions)	1**	360	1, 2, 3, 4	–	31 DB	High	High	Top
Manned-Orbit Support (3 Missions)	1*	360	1, 2, 3, 4*	–	30 DB	High	High	Top
Manned-Orbit Support (3 Missions)	–	–	–	77 x 10^9	10^{-6}	Top	High	Top
Astronomy Satellite (1 Satellite)	2-4**	26 x 10^3	1, 2, 3, 4	–	42 DB	High	Low	High
Astronomy Satellite (1 Satellite)	–	–	–	32 x 10^6	10^{-4}	High	Low	High
Satellite Control (5 Ground Stations)	–	–	–	156 x 10^9	10^{-5}	High	Med	High
Aircraft Collision Avoidance	–	–	–	31.6 x 10^7	10^{-6}	Top	Low	Top
Weather Satellite (1 Center)	2**	17,500	1, 2, 3, 4	–	37 DB	High	Low	High
Weather Satellite (1 Center)	–	–	–	35 x 10^8	10^{-5}	High	Low	High
Weather Ocean Data Ships (450 Ships)	26*	6250	1, 2, 3, 4	–	30 DB	Low	Low	Low
Migration Data, Fish (100 Fish)	–	–	–	100 x 10^4	10^{-5}	Med	Low	Low
Migration Data, Animals (5 Animals)	–	–	–	365 x 10^3 (Analog)	10^{-3}	Med	Low	Low
Deep Space (3 Probes)	3**	24	1, 2, 3, 4	–	42 DB	High	Med	High
Deep Space (3 Probes)	–	–	–	288 x 10^5	10^{-6}	High	High	Med
On-Orbit Assembly	–	–	–	–	–	–	–	–
On-Orbit Assembly	–	–	–	–	–	–	–	–
Enroute, Air Traffic Control, Commercial (1077 Movements)	–	–	–	5 x 10^{10}	10^{-6}	High	Low	High
III. INQUIRY AND RESPONSE NETWORK								
Medical Diagnostic (50 Regions)	1	20 x 10^3	2, 3	–	42 DB	High	Med	High
Medical Diagnostic (50 Regions)	–	–	–	350 x 10^3	10^{-6}	High	Med	High
Employment Records (3 x 10^6 People)	–	–	–	32 x 10^6 (Teletype)	10^{-2}	High	Med	High
IV. COMPUTER INFORMATION NETWORK								
Computer Time Share Services (100 x 10^2 Customers)	–	–	–	76 x 10^{15}	10^{-6}	High	High	High

Table 12

SUMMARY OF ITS FUNCTIONAL REQUIREMENTS – 1975

Service and Demand Title (No. of Users, Terminals, Mission, etc.)	Types and Quantity of Information				Message Characteristics			
	Voice and Video (Or Voice Only* – Video Only**)			Digital	Quality	Reliability	Privacy	Priority
	Number of Channels	Channel-Hours Per Year	Time Blocks (1, 2, 3, 4)	Bits Per Year				
I. INFORMATION DISSEMINATION AND BROADCAST NETWORK								
Education, Developing Nations (6×10^3 Terminals)	25	100×10^3	2, 3, 4	–	37 DB	Med	Med	Med
Education, Preschool (21×10^4 People)	1	375	2	–	37 DB	Med	Med	Med
Education, Grade School (34×10^6 People)	1	52	2	–	37 DB	Med	Med	Med
Education, Adult (134×10^6 People)	1	363	2	–	37 DB	Med	Med	Med
Civil Defense, Emergency Communications (230×10^6 People)	–	–	–	12×10^3	10^{-5}	High	Low	Top
Civil Defense, Emergency Communications (230×10^6 People)	1	24	1, 2, 3, 4	–	37 DB	High	Low	Top
Elec. Meetings, United Nations (174 Members)	12	125, 000	2, 3, 4	–	37 DB	Med	High	Med
Education, Ailing at Home (30×10^4 People)	1	730	2, 3	–	37 DB	Med	Med	Med
Meetings, Legislators (1100 Legislators)	2	44×10^5	2, 3	–	37 DB	Med	High	Med
Meeting, Political (30×10^3 Members)	20**	4×10^4	2, 3	–	37 DB	Med	High	Med
Civil Defense, Emergency Warning (230×10^6 People)	–	–	–	160×10^3	10^{-4}	High	Low	Top
Civil Defense, Emergency Warning (230×10^6 People)	1	121	1, 2, 3, 4	–	31 DB	High	Low	Top
Education, High School (15×10^6 People)	1	750	3	–	37 DB	Med	Med	Med
Education, Criminal Rehab (300×10^3 People)	1	250	4	–	37 DB	Med	Med	Med
Education, Rural Community (3.5×10^6 People)	See Education – Criminal Rehabilitation, High School, Adult, and Grade School Demands							
II. DATA COLLECTION AND DISTRIBUTION NETWORK								
Earth Resources Satellite (1 Satellite)	3**	18, 000	1, 2, 3, 4	–	37 DB	High	High	High
Earth Resources Satellite (1 Satellite)	–	–	–	432×10^9	10^{-5}	High	High	Top
Weather Balloon Data (1000 Balloons)	–	–	–	14.60×10^{10}	10^{-4}	Med	Low	Med
Orbit-Flight Testing (5 Tests)	–	–	–	655×10^7	10^{-5}	High	High	High
Weather Buoy Data (700 Buoys)	–	–	–	14×10^{11}	10^{-4}	Med	Low	Med
Manned Orbit Support (5 Missions)	2**	1, 200	1, 2, 3, 4	–	37 DB	High	High	Top
Manned-Orbit Support (5 Missions)	30*	1, 800	1, 2, 3, 4	–	30 DB	High	High	Top
Manned-Orbit Support (5 Missions)	–	–	–	108×10^{11}	10^{-6}	Top	High	Top
Astronomy Satellite (1 Satellite)	2-4**	26×10^3	–	–	42 DB	High	Low	High
Astronomy Satellite (1 Satellite)	–	–	–	640×10^6	10^{-5}	High	Low	High
Satellite Control (5 Ground Stations)	–	–	–	3150×10^9	10^{-5}	High	High	High
Aircraft Collision (6500 Aircraft)	–	–	–	31.6×10^7	10^{-6}	Top	Low	Top
Weather Satellite (3 Centers)	3**	26, 400	1, 2, 3, 4	–	42 DB	High	Low	High
Weather Satellite (3 Centers)	–	–	–	700×10^{11}	10^{-5}	High	Low	High
Weather Ocean Data Ships (850 Ships)	–	–	–	350×10^7	10^{-5}	Med	Low	Low
Migration Data, Fish (100 Fish)	–	–	–	50×10^4	10^{-5}	Med	Low	Low
Migration Data, Animals (50 Animals)	–	–	–	365×10^3	10^{-4}	Med	Low	Low
Deep Space (3 Probes)	3**	81	1, 2, 3, 4	–	42 DB	High	Med	High
Deep Space (3 Probes)	–	–	–	1000×10^6	10^{-6}	High	High	Med
On-Orbit Assembly (1 Center)	2**	17, 500	1, 2, 3, 4	–	42 DB	High	Low	High
On-Orbit Assembly (1 Center)	–	–	–	63×10^{10}	10^{-6}	High	High	High
Enroute Air Traffic Control, Commercial (1307 Movements)	–	–	–	11×10^{10}	10^{-6}	High	Low	High
III. INQUIRY AND RESPONSE NETWORK								
Medical Diagnostic (50 Regions)	1	20×10^3	2, 3	–	42 DB	High	Med	High
Medical Diagnostic (50 Regions)	–	–	–	350×10^3	10^{-6}	High	Med	High
Employment Records (3×10^6 People)	–	–	–	316×10^6	10^{-5}	High	Med	High
IV. COMPUTER INFORMATION NETWORK								
Computer Time Share Services (350×10^3 Customers)	–	–	–	196×10^{16}	10^{-6}	High	High	High

Table 13

SUMMARY OF ITS FUNCTIONAL REQUIREMENTS – 1985

Service and Demand Title (No. of Users, Terminals, Missions)	Types and Quantity of Information				Message Characteristics			
	Voice and Video (Or Voice* Only – Video** Only)			Digital				
	Number of Channels	Channel-Hours Per Year	Time Blocks (1,2,3,4)	Bits Per Year	Quality	Reliability	Privacy	Priority
I. INFORMATION DISSEMINATION AND BROADCAST NETWORK								
Education, Developing Nations (8×10^3 Terminals)	40	160×10^3	2,3,4	–	37 DB	Med	Med	Med
Education, Preschool (26×10^6 Users)	1	500	2	–	37 DB	Med	Med	Med
Education, Grade School (30×10^6 Users)	1	365	2	–	37 DB	Med	Med	Med
Education, Adult (157×10^6 Users)	1	363	2	–	37 DB	Med	Med	Med
Civil Defense, Emergency Communications (270×10^6 Users)	–	–	–	163×10^3	10^{-5}	High	Low	Top
Civil Defense, Emergency Communications (270×10^6 Users)	1	24	1,2,3,4	–	37 DB	High	Low	Top
Elec, Meetings, United Nations (174 Members)	36	11×10^5	2,3	–	37 DB	Med	High	Med
Education, Ailing at Home (30×10^4 Users)	1	2920	2,3	–	37 DB	Med	Med	Med
Meetings, Legislators (1100 Legislators)	4	88×10^5	2,3	–	37 DB	Med	High	Med
Meeting, Political (50×10^3 Users)	20	4×10^4	2,3	–	37 DB	Med	High	Med
Civil Defense, Emergency Warning (270×10^6 Users)	–	–	–	180×10^3	10^{-5}	High	Low	Top
Civil Defense, Emergency Warning (270×10^6 Users)	1	121	1,2,3,4	–	31 DB	High	Low	Top
Education, High School (15×10^6 Users)	1	2000	3	–	37 DB	Med	Med	Med
Education, Criminal Rehab (350×10^3 Users)	1	250	4	–	37 DB	Med	Med	Med
Education, Rural Community (43.5×10^6 Users)	See Education – Criminal Rehabilitation, High School, Adult, and Grade School Demands							
II. DATA COLLECTION AND DISTRIBUTION NETWORK								
Earth Resources Satellite (1 Satellite)	2-4**	24,000	1,2,3,4	–	42 DB	High	High	High
Earth Resources Satellite (1 Satellite)	–	–	–	432×10^9	10^{-6}	High	High	Top
Weather Balloon Data (3500 Balloons)	–	–	–	23×10^{11}	10^{-5}	Med	Low	Med
Orbit-Flight Testing (10 Tests)	–	–	–	262×10^8	10^{-6}	High	High	High
Weather Buoy Data (5000 Buoys)	–	–	–	73×10^{12}	10^{-4}	Med	Low	Med
Manned Orbit Support (10 Missions)	6**	7200	1,2,3,4	–	42 DB	High	High	Top
Manned-Orbit Support (10 Missions)	50*	12×10^3	1,2,3,4	–	45 DB	High	High	Top
Manned-Orbit Support (10 Missions)	–	–	–	43×10^{11}	10^{-6}	Top	High	Top
Astronomy Satellite (1 Satellite)	2-4**	52×10^3	1,2,3,4	–	42 DB	High	Low	High
Astronomy Satellite (1 Satellite)	–	–	–	1280×10^6	10^{-6}	High	Low	High
Satellite Control (5 Terminals)	–	–	–	3150×10^9	10^{-6}	High	High	High
Aircraft Collision Avoidance (12,000 Users)	–	–	–	31.6×10^7	10^{-6}	Top	Low	Top
Weather Satellite (3 Terminals)	5**	44,000	1,2,3,4	–	37 DB	High	Low	High
Weather Satellite (3 Terminals)	–	–	–	700×10^{11}	10^{-6}	High	Low	High
Weather Ocean Data Ships (1000 Ships)	–	–	–	455×10^7	10^{-5}	Med	Low	Low
Migration Data, Fish (1000 Fish)	–	–	–	500×10^4	10^{-5}	Med	Low	Low
Migration Data, Animals (100 Animals)	–	–	–	730×10^3	10^{-5}	Med	Low	Low
Deep Space (5 Probes)	3**	5475	1,2,3,4	–	42 DB	High	Med	High
Deep Space (5 Probes)	–	–	–	6560×10^9	10^{-6}	High	High	Med
On-Orbit Assembly (2 Terminals)	4**	70,000	1,2,3,4	–	42 DB	High	Low	High
On-Orbit Assembly (2 Terminals)	–	–	–	126×10^{10}	10^{-6}	High	High	High
Enroute Air Traffic Control, Commercial (1645 Users Average)	–	–	–	41×10^{10}	10^{-6}	High	Low	High
III. INQUIRY AND RESPONSE NETWORK								
Medical Diagnostic (50 Terminals)	1	34×10^3	2,3	–	42 DB	High	Med	High
Medical Diagnostic (50 Terminals)	–	–	–	1400×10^3	10^{-6}	High	Med	High
Employment Records (5×10^6 Users)	–	–	–	44×10^7	10^{-5}	High	Med	High
IV. COMPUTER INFORMATION NETWORK								
Computer Time Share Services (1×10^6 Users)	–	–	–	2000×10^{16}	10^{-6}	High	High	High

The digital information was quantitized by using the units "bits per year." These data were derived from the estimates provided from the working material matrices delineating the message spacing and duration.

An overall appraisal of the results, that is the functional requirements for the 31 selected demands as shown in Tables 11, 12, and 13, indicate system commonalities and a large spread in quantities of data to be transferred. For example. of the wide spectrum of quantity of data in the video/voice information type, the quantities went from 2×10^4 to 2.62×10^7 channel hrs per year. The maximum value was for "tele-conferencing of legislators meetings." Within the digital type of data, this spread went from a minimum of 3.5×10^5 bits/year for medical diagnostic to 2000×10^{16} bits/year for computer time share services." These two demands, representing maximum quantity of data, overwhelmed their respective categories and therefore it was necessary to treat them separately in many of the following figures .

Types of Information Required

A graphic Summary of the number of demands requiring various types of information is shown for the three time periods in Figure 20.

It is seen from the figure that within the 31 selected demands there were more demands requiring digital type information than any of the other types within the 15 year time span. However a more important derivative from this figure was the indication of change in type of information in the 1970 to 1975 time period, as compared with very little change in the period from 1975 to 1985. The implication, of course, is the fact that voice as a separate means of transfer of information will convert to a voice/video type of transfer of information.
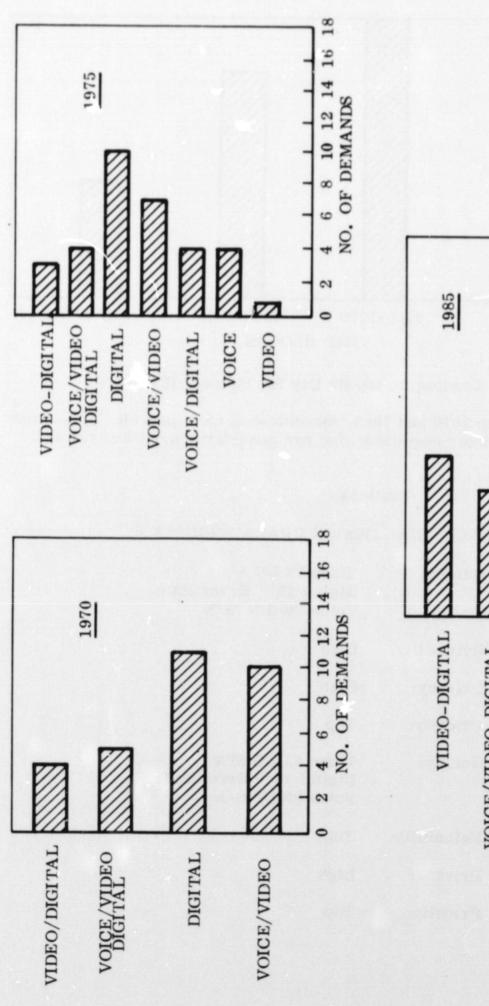
Another factor that can be gleaned from the functional requirements was the fact that all of the 31 demands require coverage of at least the United States, as contrasted to just regions, and many require global coverage in order to provide benefits to the United States. Considering all information types in the sample, the coverage distribution is 17 for the U.S. and 23 global. It should also be mentioned that those demands requiring U.S. coverage have global overtones, inasmuch as they include Alaska and Hawaii. In several cases, American Samoa is included. These facts were not chartered.

Time Block Requirements

Summarizing the time block requirements, there were no significant differences in loading throughout a 24 hr day, nor did it vary much in progressing from 1970 to 1985. However, on a network basis, the daily loading is almost continuous for the 24 hour loading period for the Data Collection and Distribution Network, while in the other networks, information transfer is required for only a portion of the day. A typical loading curve for Network II in 1985 is shown in Figure 21.

Message Characteristics

The message characteristics do not show a marked distribution within the relative levels established for the three time periods. This is also true for quality, reliability, privacy, and priority. However, it was considered beneficial to determine those characteristics that would be most difficult to achieve on a concept design basis within a network category. These are identified in Tables 11, 12, and 13 by cross hatching the characteristics per column within a network category. Since there were no
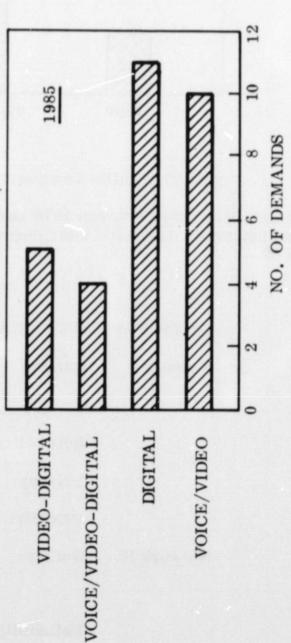
Figure 20 Information Type Vs. Number of Demands
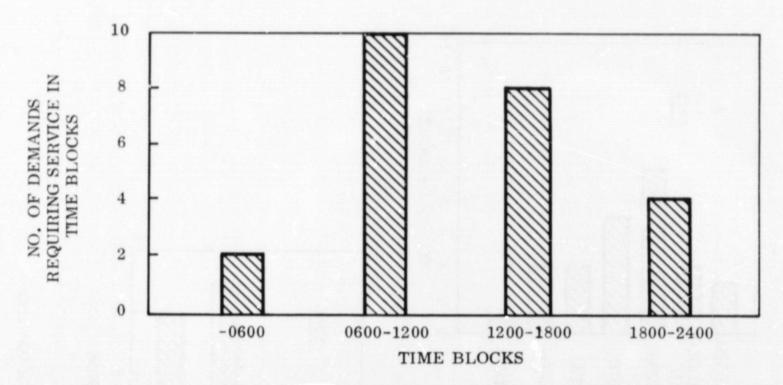
Figure 21 Traffic Loading for 24-Hr Day for Network II in 1985

significant differences between 1970 and 1985, the following table provides a summary of those functional items and their magnitude that are considered most difficult to design to.

Table 14

DIFFICULT FUNCTIONAL DESIGN CHARACTERISTICS

Network I	Quality:	Video 37 DB S/N Digital 10^{-5} Error Rate Voice 30 DB S/N
	Reliability:	High
	Privacy:	High
	Priority:	Top
Network II	Quality:	Video 42 DB S/N Digital 10^{-6} Error Rate Voice 30 DB S/N
	Reliability:	Top
	Privacy:	High
	Priority:	Top

Table 14   (Continued)

Network III   Quality: Video 42 DB S/N
                              Digital 10^{-6} Error Rate

               Reliability: High

               Privacy: Med

               Priority: High

Network IV   Quality: Digital 10^{-6} Error Rate

               Reliability: High

               Privacy: High

               Priority: High

Of the 31 selected demands it is seen that excellence in message characteristics is not required throughout all four network categories, indicating excellence of performance is not a universal requirement.

Categorization

In a further analysis of the quantities of information transferred for the 31 selected demands two categorizations are used; one is the network categorization which is service oriented and secondly; a functional categorization. Both have been discussed previously. The breakdown of the 31 selected demands into their respective functional categories is as follows:

Education: Education Programs for Developing Nations
                        Education Programs for Pre-School
                        Education Programs for Ailing at Home
                        Education Programs for High School Student
                        Education Programs for Criminal Rehabilitation
                        Education Programs for Rural Schools
                        Education Programs for Grade School
                        Education Programs for Adult Education

Teleconferencing: Legislative Meeting or Sessions
                        Political Presentations and Meetings
                        U. N. Meetings

Civil Defense: Emergency Warning Data
                        Emergency Communication Data

Earth Sciences: Earth Resources Data
                        Migration Data on Fish
                        Migration Data on Animals

Weather Data: Weather Balloon Data Relay
                        Weather Buoy Data Relay
                        Weather Satellite Data Relay
                        Weather Ocean Ships Data Relay

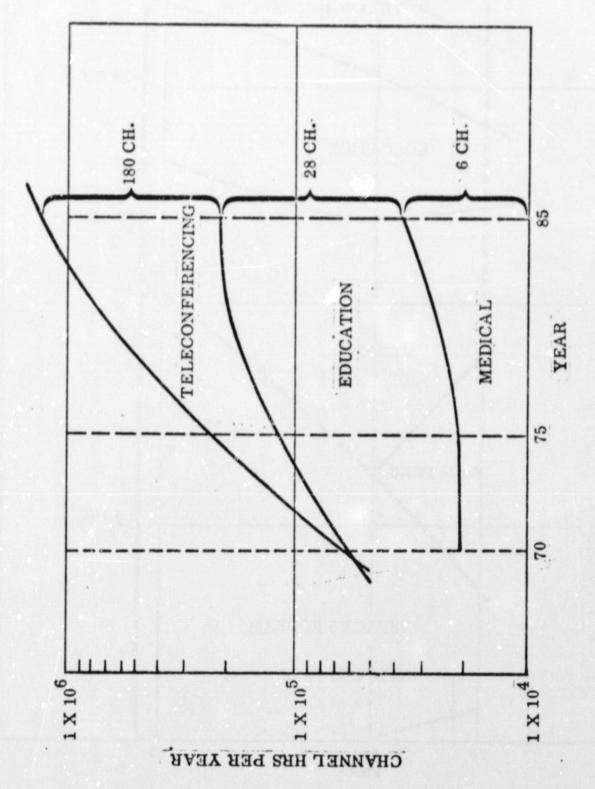| Space Programs: | Support of Manned Orbit Operations |
	Astronomy Data Relay
	Satellite Control Data Relay
	Deep Space Probe Data Relay
	Assist on Orbit Assembly
	10-Orbit Flight Testing
Aircraft:	Aircraft Collision Avoidance
	Enroute Air Traffic Controo, Commercial
Welfare:	Centralizing and Relaying of Employment Records
Medical:	Relay of Medical Diagnostic Data and Consulting Services
Computer Services:	Time Share Services

Summarization of Data Quantity

Summarization of the total quantity of data estimated to satisfy the 31 demands during the periods of 1970, 1975, and 1985 provides a pattern for the information transfer requirements undertaken by this study, and is shown in Figures 22, 23, 24, and 25. The quantities shown are summarized on a functional category basis for 31 of a total of 135 identified and screened demands. This represents a sample size of 23 percent, in terms of demands, or approximately 30 percent in terms of categories. In Figure 22 the video/voice type of transfer of information is shown for the three predominating functional categories — teleconferencing, medical, and education. A moderate increase in information transfer is shown during the time period for the three categories. The demand for transfer of Legislators Meetings information under the teleconferencing category has not been included in the figure due to its magnitude and swamping effect on all other data (132×10^5, channel hrs/hr for 1970 and 1975 and 264×10^5 for 1985) also because of a lack of acceptance of the service.

The amount of voice/video data represented on a dedicated channel basis for 1985 are 28 channels for education, 6 channels for medical, and 180 channels for teleconferencing. The estimates for number of channels would be modified downward if consideration was given to modulation and radiation techniques. A review of the large number of channels for transfer of teleconferencing data is due to a wide physical separation of terminals, requiring a large number of channels, and continuous use during the working day. Consequently redundant usage of frequencies and narrow antenna beamwidths would be a means of reducing channel requirement. It should also be recognized that this demand is representative of a videophone type service which will take over a great amount of voice only phone traffic. For the above reasons, the large quantities of data transferred is understandable. The reader is cautioned that the data are for the selected demands and do not represent total traffic projections.

Figure 23 graphs the data transfer quantities for voice. In this figure the data transfer requirements include voice/video as well as the data that are transferred by voice only. Consequently it incorporates Figure 22 data. One significant point to be made is the fact that although the weather category makes use of voice now, it is anticipated this will be taken over completely by video/voice as time progresses. Civil defense is in this same period of evaluation whereby warnings and communications are to a large extent handled by radio; however, it will eventually be converted totally to video/voice as time progresses.

NOTE: (1) LEGISLATURE TELECONFERENCING HAS NOT
BEEN INCLUDED DUE TO ITS MAGNITUDE
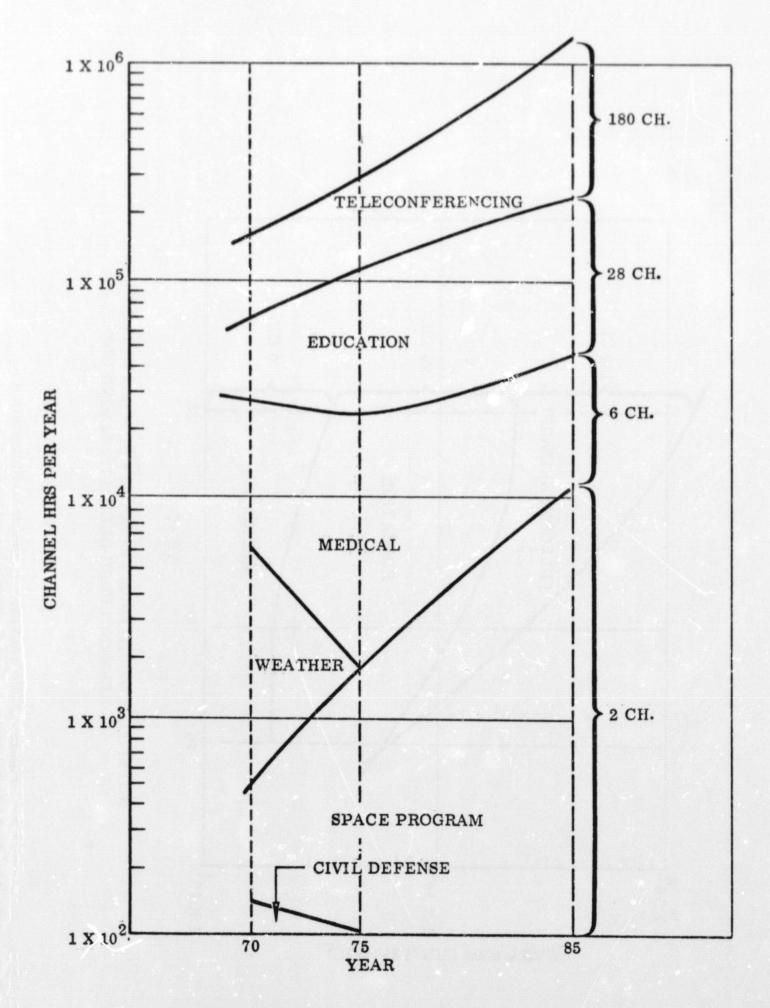
Figure 22 Voice/Video Transfer of Information

97

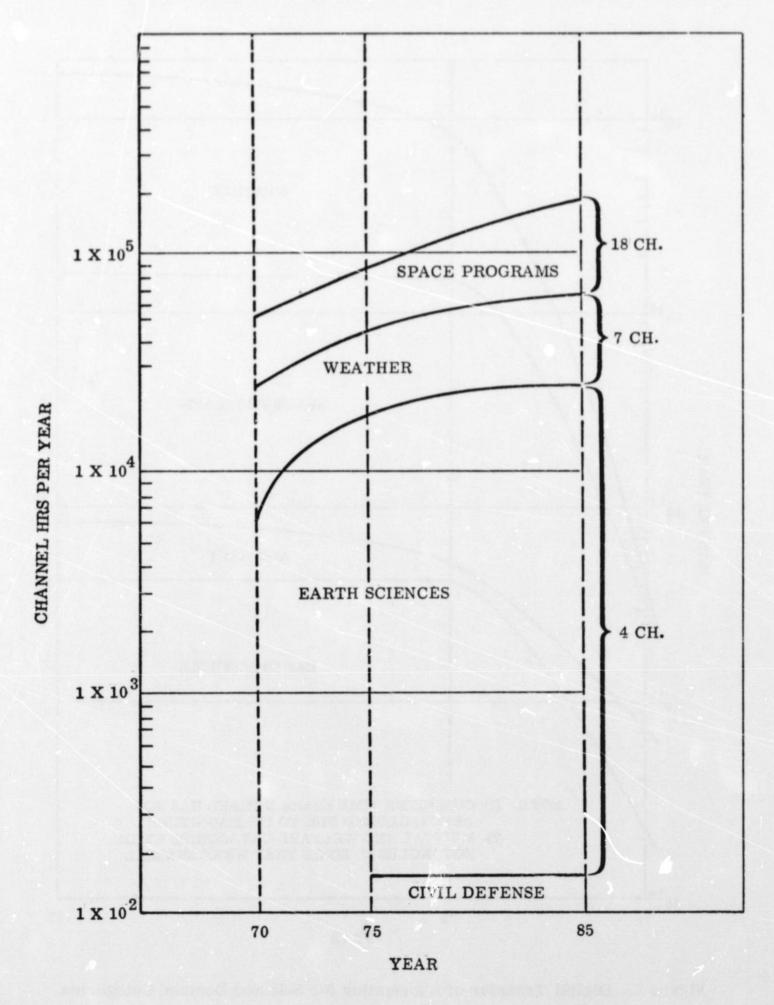Figure 23 Voice Transfer of Information

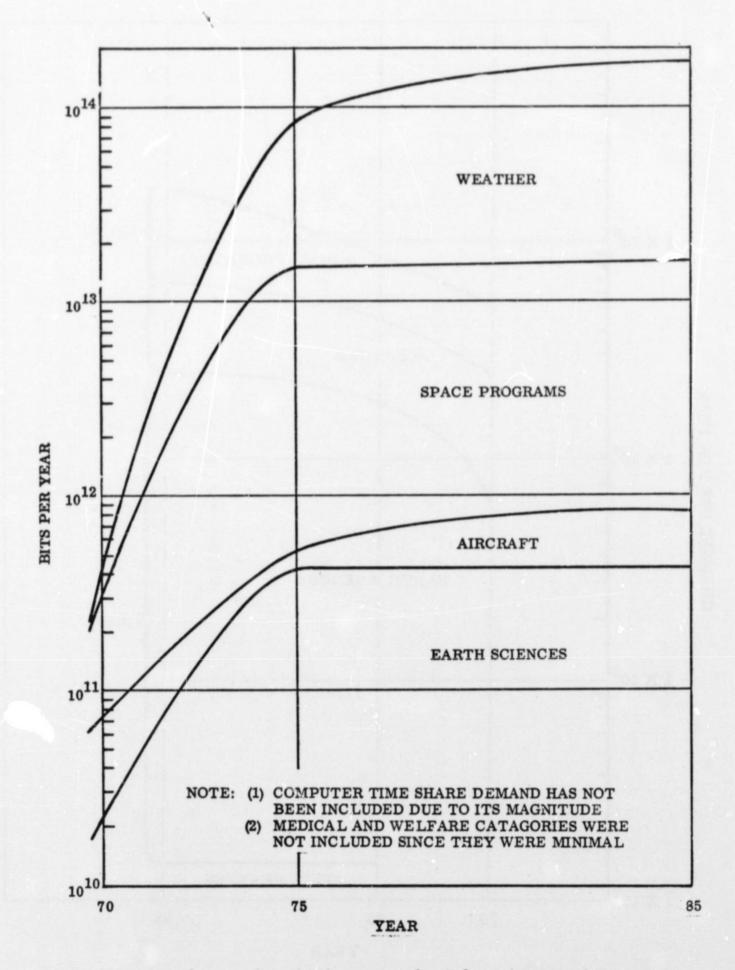Figure 24 Video Transfer of Information for Selected Demand Categories

Figure 25 Digital Transfer of Information for Selected Demand Categories

100

Space programs category requirements for voice transfer will increase only due to number of satellites in orbit. The need for voice transfer in the medical category is expected to increase initially and then decrease as video takes over, while education increases in accordance with the demand for video/voice transfer of data.

Teleconferencing will increase throughout the period due to increased usage of video/voice as time progresses. The number of channels required are dedicated channels and therefore indicate a large traffic load; yet this does not represent the total load because this category does not include "legislative teleconferencing." The large traffic load in this category is, of course, because these demands include the transfer of information that is now handled by telephone.

Figure 24 charts the quantity of video information transfer only, for the four categories of Space Programs, Earth Sciences, Weather, and Civil Defense. The increases noted are reasonable; however, the flattening of the curves during the 1975 and 1985 periods is mostlikely due to the difficulty of forecasting needs in a time period beyond five years.

Figure 25 represents the transfer of digital data for four functional categories — Earth Sciences, Weather, Space Programs, and Aircraft. Three demand categories are not included because of the spread in amounts of data required. The computational category was so large (76 x 10^{15}, 196 x 10^{16}, and 2000 x 10^{16} bits/year for 1970, 1975, and 1985, respectively) that it swamped all other requirements. At the other end of the demand spectrum, Medical (3.5 x 10^5, 3.5 x 10^5, 1.4 x 10^6 bits/year for 1970, 1975, and 1985, respectively) was minimal and therefore difficult to plot. Welfare was also minimal (3.2 x 10^7, 3.2 x 10^8 and 4.4 x 10^8 bits per year for 1970, 1975, and 1985). The significance of Figure 25 is the relative growth of the three categories — Weather, Space Programs, and Earth Sciences — during the next five years, as compared with the ensuing ten years from 1975 to 1985. Each one of these categories will most likely be government sponsored. The Aircraft category is considered to be more business-oriented, and, consequently, will grow at a more normal rate.

One further pattern can be derived from a summation of study results by applying network categories to all 134 identified and screened demands. Assuming that the 31 most promising demands were of sufficient benefit to the United States to prompt the implementation of their respective network groups, then an expansion of this capability would also permit the accommodation of some of the lower ranking demands.

There were 134 demands identified and screened, within the constraints of this study, to have long-haul information transfer needs and of benefit to the United States. The services to satisfy the remaining 103 demands are shown in Figure 26 when applied to the appropriate network group.

Two facts are apparent from Figure 26; first, the most promising demands resulted in a reasonably good sample of the total number of demands; second, strikingly few demands were selected as most promising by the study methodology in relation to total number of demands forthe Inquiry and Response net. These demands include library, business, and government records. Many of these demands were not selected because of a relatively aggressive action by industry and government to develop services in those areas. Some cost effectiveness influences are also indicated in this area due to the need for large amounts of terminal equipment to effectively implement the network.
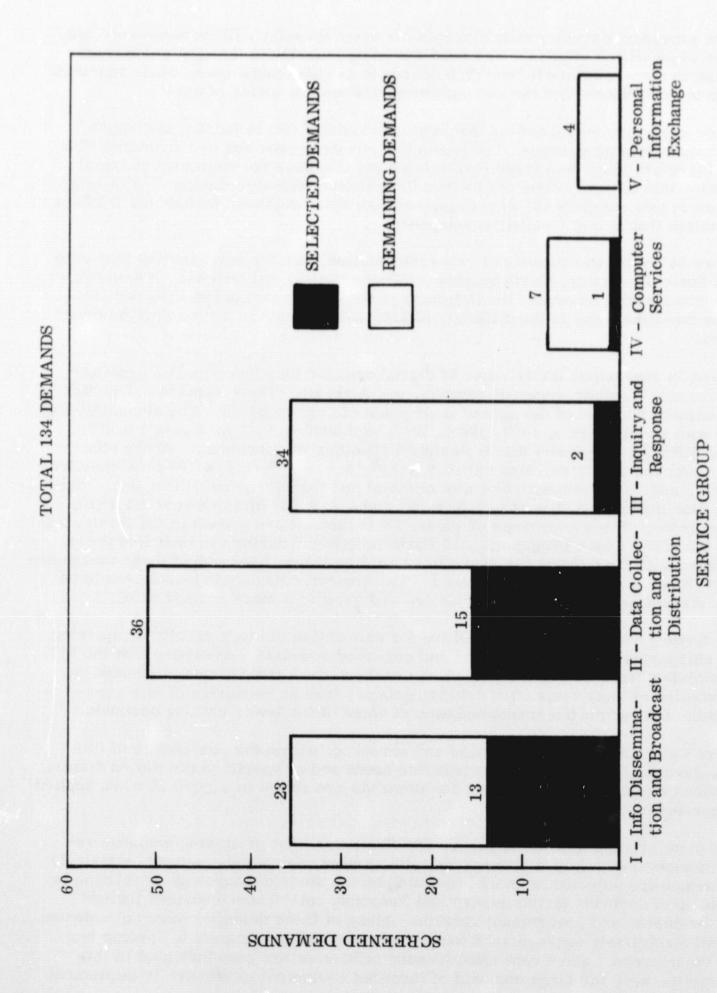
Figure 26 Application of Total Screened Demands to Network Groups

CONCLUSIONS

This study was broad and very general in its approach; consequently, the conclusions must be provided in the same vein. Thirty-one most promising demands were selected in accordance with the evaluation parameters established by the study. These demands meet the basic premise of the study — that they be beneficial to the nation, amenable to a satellite-type service, and in a category that will be implemented only if they receive government encouragement. However, of these 31 selected demands there were two demands that were considered excellent candidates for the title of "most likely to succeed." They are those demands that fall within the Education and Medical categories. These two demand categories have the characteristics of (1) largest projected expenditure of monies in the time period between 1970 and 1990, and (2) egalitarianism, of which there are now many signs which could well lead, for example, to increase in the demand for "public" goods and services such as mass education and health care.

The categories that follow the above two categories in expenditure of monies are:

> Police Protection
> Welfare
> Computer Equipment Sales
> TV Advertising
> Avionics Equipment
> Space Programs
> Natural Resources Programs

Of these nine categories, there were only two not represented within the 31 selected demands. These were Police Protection and TV Advertising. Within the study these two categories were considered as well established networks which did not need added encouragement by government.

In the United States, telecommunications is essential to the efficient operation of government, industry and commerce, finance, and education. The importance of the information transfer services can be depicted by the fact that it involves over 16 billion dollars based on a percentage figure of the GNP and constant dollars (1958). From the study it was concluded there are three determinants of the degree and diversity in the future use of telecommunications. They are: technology advancement, social acceptance, and government sponsorship.

The application of a new technology can result in the reduction of costs and in the improvement of quality of conventional communication services; however, its most important contribution must be in the area of terminal equipment. There is at present a lack of "highly specialized" terminal equipment. The assimilation of data now being transmitted is limited by the lack of cost efficient inputting, display, storage, and retrieval equipment. Terminals are becoming saturated with information. Relief of this situation can come from two directions; new terminal equipment must be developed, or the data to be transferred must be carefully selected to reduce the amount to a bare minimum. The latter can only be accomplished if the requirements for selected demands are examined in more detail than has been accomplished in this broad study. The advancement of technology for recording (video tape recorder) and distribution (CATV) will also play a very important part in those demands for education services, due to the fact that editing and redistribution at more appropriate times is a necessary requirement of this demand.

Throughout the study it became very apparent that services to satisfy a demand can only be implemented if there exists a universal social acceptance for the service. This is particularly important in the areas involved in teleconferencing, welfare, and civil defense categories. Promoting the acceptance and use of these services is a very necessary and important part of implementation. Therefore, the needs for public acceptance (public relations) should be investigated in depth.

Although one of the parameters used to select the 31 most promising demands was the need for governmental sponsorship, it can be concluded in a general way that government sponsorship must come from one or all of three directions; one is for the government to provide regulatory decisions favoring a more open market in the communication industry. If this comes about, it will help accelerate the rate of introduction of the new, more efficient technologies into the nation's public and private networks. The second is for government to finance many of the demands for service, such as earth resources data relay and the migration data on fish and animals, since there may be insufficient profit motivation in those demands that will benefit mankind. Third, a national telecommunication goal must be established for each of those demands considered to be important to undertake in the next decade. Once this goal is established, the individual design concept problems will be more easily solved since they will be focussed towards one objective.

The future methods for transferring information, at least for the 31 most promising demands, indicate that the quantity of data transmitted by video data transmission will exceed voice, since the future trend is toward accompanying each voice transmission with a picture, while the reverse is not always true (each video or data transmission does not always need voice). It is also evident from the curves for digital transfer data that this type of information transfer will nearly equal the transfer of video/voice information. On the basis of number of demands for services, the study has indicated generally that the long-haul requirement for transfer of information is approximately 10 percent of the demand for short-haul transfer of information.

A final conclusion drawn from the study experience indicates that the objective of providing functional requirements for the thirty-one selected demands was a difficult task, since many of the functions were based on assumptions that were subjective and could not be completely documented. These assumptions were critical, for example, in the demand category of teleconferencing, where it was very difficult to determine communication traffic loads, even in the 1970's. It therefore is concluded that the functional requirements should not be accepted as absolute figures but rather as indicators of communication traffic load trends. On this basis, any conclusions drawn from the patterns established by the functional requirements must be tempered by the fact that they were drawn from a general study that begs for a more detailed study of the selected demands.

RECOMMENDATIONS

The conclusions derived from this study might suggest advantages of a service dedicated satellite system. Although such an approach is sound, it is time consuming and could be a very expensive program.

Another approach therefore is recommended that may be more within the scope of NASA's objectives and would prove the practicability of implementing an information transfer service to satisfy selected demands — and would also prove the benefits to be derived — before committing large amounts of money or time. Reference is made to the NASA experimental satellite programs. These programs, with launching from 1972 onward, already incorporate technology to handle aeronautical communication, educational, and space relay missions which are selected as most promising demands in this study. However, the present approach is basically an experiment to validate technology considerations rather than from a user's standpoint. This could be modified by incorporating experiments involving user requirements. An objective to satisfy these requirements would certainly be in consonance with NASA's overall objective of increasing utilization of space capabilities for services to man, through an expanded space applications program.

It therefore is recommended that the following generalized approach be taken to implement a telecommunications experiment on future NASA application satellite systems:

1. Finalize all data provided on the thirty-one most promising demands, in preparations for reducing the selected demands to not more than three by taking the following actions:

   a. Compile detailed profiles and research material on the selected demands.
   b. Firm up their functional requirements.
   c. Present the compiled data to the anticipated users in each demand category (11) to obtain either their acceptance or rejection, in the form of an experts critique of the material presented.

2. Reduce the selected demands to not more than three, by applying the two techniques already developed, i.e., benefit and amenability to service, and by the use of the data provided by step 1.
3. Relate the newly selected demands to the experimental satellite concepts:

   a. Investigate and provide ground system requirements.
   b. Investigate and provide satellite system requirements.
   c. Document the requirements for presentation to the cognizant NASA satellite experiment office.
   d. Formulate an "Information Transfer Experiment" objective and test plan.

REFERENCES

1. A Methodology for Systems Engineering, D. Van Nostrand Co., Inc., by Arthur D. Hall, Bell Telephone Laboratories.

2. Data Communication Requirements for Computer Systems, John C. McPherson, International Business Machines Corp.

3. Automation and Economic Progress, Howard R. Bowen and Garth L. Mangum, Prentice-Hall, Inc., pages 115, 116, 19, 12, and 13.

4. Science & Technology, April 1968, International Communications, Inc., pages 6 and 14.

5. The Production and Distribution of Knowledge in the United States, Fritz Machlup, 1962, Princeton University Press, pages 382, 388, Library of Congress Catalog Card No. 63-7072.

6. Computers and Communications — Toward a Computer Utility, edited by Fred Gruenberger, 1968, Prentice-Hall Inc., pages 173, 175, 176, 178, 182, 183, and 185.

7. U.S. Industrial Outlook, 1967, 1968, U.S. Dept. of Commerce/Business, and Defense Administration.

8. Natural Resources for U.S. Growth, by Hans H. Landsberg, Published for Resources for the Future, Inc., by the Johns Hopkins Press, Baltimore, Library of Congress Catalog Card No. 64-24348, pages 9, 10, 17, 20, 26, 48, 67, 78, 86, 100, and 103.

9. The Impact of Information Transfer Satellites on Everyday Living, George E. Fosdick, George W. Morgenthaler, and John E. Cervi, a paper presented at ORSA 34th Annual Meeting, Nov. 6-8, 1968, Philadelphia, Penna.

10. Economic Models, E. F. Beach, Professor of Economics, McGill University, published 1957 by John Wiley & Sons, Inc., Library of Congress Catalog Card No. 57-10800.

11. Econometric Models and Methods, Carl F. Christ, Professor of Political Economy, Johns Hopkins University, published by John Wiley & Sons, Inc., Library of Congress Catalog Card No. 66-21050.

12. Statistical Abstracts of the United States, 1969

13. Data Communications in Business, Edgar C. Gentle, Jr., American Telephone and Telegraph Co., Published by Publishers Service Co., 1965, 75 Varick Street, New York, N.Y.

14. Forecasting by Trend Extrapolation, Thomas I. Monahan, Naval Applied Science Laboratory, Brookland, New York; presented at the 1969 Joint National Meeting, Operations Research Society of America, American Astronomical Society; Denver, Colorado, June 1969.

BIBLIOGRAPHY

George E. Fosdick and George W. Morgenthaler: "Planning the Exploitation of Space—Multi-Mission Information Transfer Satellites: The Next Step." Paper presented at the Second Conference on Planetology and Space Mission Planning, New York Academy of Sciences, New York, Oct. 26-27. 1967.

Daniel Bell: Toward the Year 2000, Work in Progress. The Daedalus Library Vol 11. Houghton Mufflin Co., Boston, 1968.

H. Kahn and A. J. Wiener: The Year 2000: A Framework for Speculation on the Next Thirty-Three Years, Hudson Inst., Croton-on-Hudson, N.Y., 1967.

Herman Kahn: "Speculations on the Year 2000: Tutorials I, II, III." 34th National ORSA Meeting, Philadelphia, Pa., November 6-8, 1968 (2 handouts).

Commission Staff, National Planning Association: Projections to the Years 1976 and 2000: Economic Growth, Population, Labor Force and Leisure, and Transportation. Reports to the Outdoor Recreation Resources Review Commission. ORRRC Study Rept 23, Wash., D.C., 1962.

1960 Census of Population, Vol I. Characteristics of the Population. Part I, United States Summary, U.S. Dept. of Commerce, Bureau of the Census.

Statistical Abstract of the United States, Bureau of the Census, U.S. Department of Commerce, 1900-1968.

Economic Report of the President. 1968, USGPO

The Budget of the United States Government, Fiscal Year Ending June 30, 1968, USGPO.

Vickers, T.K., "Navigation of V/Stol Aircraft in High-Density Urban Areas," Journal of the Inst. of Nav.

Gilbert, G.A., "Navigation for General Aviation," Journal of the Inst. of Nav., Vol. 14, No. 4, Winter 1967-68, p. 398

Pienkowski, T.M., "Curves for LORAN-Inertial Analysis", Journal of the Inst. of Nav., Vol. 14, No. 4, Winter 1967-68, p. 434

Dodington, S.H., "Ground-Based Radio Aids to Navigation," Ibid, p. 383

Staff Report, "A Closer Look at the SST," Journal of ATC, Jan. '68, p. 19

League, A.W., "The Terminal Area Challenge," Journal of ATC, May 1967. p. 7.

Winich, A.B., "Navigation and the Relationship to Terminal Area Capacity," Journal of ATC, March 1968, p. 14

Maritime Communication and Navigation, Maritime Satellite Service, Mario W. Cardullo, Communications Satellite Corp., Wash., D.C. Paper presented at the AIAA 2nd Communications Conference, San Francisco, Calif., April 8-10, 1968

K.G. McKay, "Networks," Science and Technology, No. 76, pp. 45-50; April, 1968

M.R. Irwin, "The Computer Utility," Datamation, v. 12, pp. 22-27; Nov. 1966

R. Gabel, Development of Separations Principles in the Telephone Industry, Michigan State University, 1967.

BEMA response to F.C.C. Docket No. 16979, Attachment 2.

Department of Justice response to F.C.C. Docket No. 16979.

The Bell System Companies response to F.C.C. Docket No. 16979, March 5, 1968.

Bell System Technical Journal, v. 43, pp. 1831-2609, September, 1964.

Western Union Telegraph Co., Proxy Statement on Proposed Merger with Computer Sciences Corporation, August 1968, p. 27.

Department of Justice response to F.C.C. Docket No. 16979, supra reference 8, Appendix A, sub-section I.

Anthony, Management Accounting, 1964

"GT&E Unit to Process Data for Parent Firm and Others," Wall Street Journal, January 11, 1968

P. Baran, "The Coming Computer Utility - Laissez Faire, Licensing or Regulation," Public Interest, Summer, 1967, pp. 75-87.

P. Baran, "Does the Interconnected Computer Network Pose a Hidden Threat of Invasion of Privacy," The Computer and Invasion of Privacy, Hearings before a Subcommittee of the Committee on Government Operations, 2d Session, July 26-28, 1966; 67-715, U.S. Govt. P.O., 1966, pp. 119-135.

A. Harrison, "The Problem of Privacy in the Computer Age: An Annotated Bibliography" RAND Corp. Report RM-5495-PR/RC, Dec., 1967.

W.K. Jones, Cases on Regulated Industries, Foundation Press, Brooklyn, 1967.

J.W. Pratt, H. Raiffa and R. Schlaifer, Introduction to Statistical Decision Theory, McGraw-Hill, N.Y., 1965.

F.S. Hillier and G.J. Lieberman, Introduction to Operations Research, Holden-Day, San Francisco, 1967.

C.J. Hitch and R.N. McKean, The Economics of Defense in the Nuclear Age, Harvard, 1960.

R.A. Howard, "Bayesian Decision Models for System Engineering," IEEE Trans. on Sys. Sci. and Cybernetics, v. SSC-1, pp. 36-40; Nov., 1965.

L.L. Johnson, "Joint Cost and Price Discrimination: The case of Communications Satellites" 37 J. Bus. U. Chi. 32 (1964) reprinted in Utility Regulation-New Directions in Theory and Policy, W. Shepherd and T. Gies, eds., 1966.

C. Kaysen, "Model Makers and Decision Makers: Economists and the Policy Process," The Public Interest, Summer, 1968, p. 80.

C. J. Grayson, Decisions under Uncertainty: Drilling Decisions of Oil and Gas Operators, Harvard, 1960.

G.M. Kaufman, Statistical Decision and Related Techniques in Oil and Gas Exploration, Prentice-Hall, Englewood Cliffs, N.J., 1963.

C. R. Spetzler, "The Development of a Corporate Risk Policy for Capital Investment Decisions," IEEE Trans. on Sys. Sci. and Cybernetics, v. SSC-4, pp. 279-300; Sept., 1968.

W. Iulo, Electric Utilities – Costs and Performance, 1961 and "The Relative Performance of Individual Electric Utilities," 38 Land Econ. 315 (1962) and "Problems in the Definition of Superior Performance" in Performance under Regulation, H. Trebin, ed., 1968.

R. Dorfman, ed., Measuring Benefits of Government Investments, Brookings Institution, 1965.

H. T. Derracott, et al: Report on Technological Forecasting. Prepared by the Interservice Technology Forecasting Methodology Study Group. Joint AMC/NMC/AFSC Commands, Washington, D.C., 30 June 1967. DDC Clearinghouse for Federal Scientific and Technical Information. AD 664165.

James E. Hacke: Forecasting Technological Change: Manual for Analysts. Stanford Research Institute Rept 334, Oct 1967 (A Research report by the Long Range Planning Service.)

G. R. Woodcock: The Problem of Space Flight Worth Analysis. NASA TM X-53174, December 8, 1964.

Future Communications Systems vis Satellites Utilizing Low Cost Earth Stations. Prepared by the Ad Hoc Group of the Engineering Committee, Satellite Telecommunications Subdivision, Industrial Electronics Division., Electronic Industries Asso., Washington, D.C., July 1968

George E. Fosdick and Robert C. Cary: "Study Results Pertaining to Selection and Evaluation of a Multi-purpose Satellite," reprinted from Journal of Spacecraft and Rockets, Vol. 5, No. 7, July 1968, pp 821-826.

Aaron N. Silver: The Remote Sensing of Earth Resources from Orbiting Vehicles. Section Report 0497-9, Martin Marietta Corporation, 1968.

Final Report of the AD HOC Joint Navigation Satellite Committee, May 1966

Product Engineering, September 11, 1967

Aeronautical Satellite System Study, Lockheed Missile & Space Company, December 16, 1966

RTCA Working Paper, 73-66/SC110/111-16

Lloyd's Register of Shipping Statistical Tables, Lloyd's of London, 1966

Allan Lytel, Marine Radio and Electronics

Maritime Satellite Service – Mario W. Casdullo, COMSAT – Engineering Notes (December 1968)

"Satellite Message to Ship Hailed," (Transport News and Notes), New York Times, April 15, 1967

Walters, J.M., "Search and Rescue Problem Areas," AMVER Bulletin, October 1966, U.S. Coast Guard

Crime in the United States by John Edgar Hoover, February 1967

San Francisco Chronicle, Thursday, April 17, 1967, Page 6

The Challenge of Crime in a Free Society, A report by the President's Commission on Law Enforcement and Administration of Justice, U.S.G.P.O., February 1967

Truck Hijackers, U.S. News & World Report, March 17, 1969, Page 42

Crime War: Key Senator Launches a Broad Attack, U.S. News & World Report, March 24, 1969

Social Trends Study, conducted by Lockheed Missiles & Space Company, June 24, 1968

Statistical Abstract of the United States, 1967, Page 155

A Modern Law Enforcement Communications Network by Donald A. Manson/ Communications Specialist, Metropolitan Police Department, St. Louis, Missouri; Page 28, Telecommunications

California Criminal Justice Information Systems Advanced 2. ription by Lockheed Missiles & Space Company, December 30, 1968,

Can EDP Win the War on Crime, DATAMATION, June 1968,

Systems in the 70's by Edward J. Menklaus, Business Automation, January 1969, Page 46

Facsimile Fills Important Role in Records Communications, by Kenneth McConnell, Litton Systems, Inc., Telecommunications, May 1968

Social Trends Study, page 127, by Lockheed Missiles & Space Company, Information Systems Department, June 24, 1969, sponsored by the U.S. Department of Justice Office of Law Enforcement Assistance

Systems in the 70's by Edward J. Menshaus, Business Automation, January 1969, page 46.

EDP Boom Keeps Rolling Along by Arnold E. Keller, Business Automation, January 1968, Page 42

Development of the "Checkless Society" by Dale L. Reistad, Deputy Manager and Director of Automation, The American Bankers Association, Computer Digest, February 1968, page 13

Electronic Money, Forbes, April 1967, page 42

Credit Card Fraud, San Jose Mercury, May 26, 27, 28, and 29, Page 1

Federal Civil Defense Guide — Emergency Communications Dept of Defense, Office of Civil Defense dated Feb 1967

Social Security Handbook, Third Edition, U.S. Department of Health, Education and Welfare, Social Security Administration, October, 1966.

Needed: A National Job-matching Network, by Gordon K. Davies, Harvard Business Review, September-October, 1969, pages 63-72

Statistical Abstract of the United States, 1969, National Data Book and Guide to Sources, 90th Edition, U.S. Department of Commerce, Bureau of the Census

Truth about Hunger in America, U.S. News and World Report, April 28, 1969

Report on the Jobless — Who and Where they Are, U.S. News and World Report, May 19, 1969

Now it's "Instant" Welfare: Impact across the U.S., U.S. News and World Report, May 5, 1969

Human Performance by Fitts and Posner, 1968, Wadsworth Publishing Co., page 5.

Long-Range Projections for Economic Growth, The National Planning Association, Washington, D.C., Library of Congress Catalog No. 59-15816.

APPENDIX A
MATHEMATICAL TREATMENT OF
DEMAND TREND ANALYSIS

Three types of trend analysis were used in the study. They were; exponential, parabolic and linear regressions. The mathematics involved in these three types are discussed in the following pages.

Exponential Analyses

Long term trend data were plotted on semi-log paper with time in years as a linear abscissa and the economic variable, such as gross national product, as a logarithmic ordinate. Such a means of plotting data produces a straight line if the variable is growing at a constant increasing rate, such as a constant percentage of each year's value. Mathematically, the economic variable may be related to time (see Figure A-1) for a straight line semi-log plot:

$$Y = a \cdot e^{bt} + c \qquad (1)$$

$$\frac{dY}{dt} = a \cdot b \cdot e^{bt} \qquad (2)$$

where:

$$e^{bt} = 1 + bt + \frac{(bt)^2}{2!} + \frac{(bt)^3}{3!} + \ldots \ldots \qquad (3)$$

Equation (1) is the Domar Macro Model, (Ref. 10), page 69. No actual historic data follows this model exactly, but it was considered representative for expressing a trend of historic data. This model does fit some data sufficiently close to serve as a useful tool for data smoothing and projection over periods of time where historic data is not available. The exponential model must be used with care, however, as will be demonstrated, since most economic variables tend to approximate an "S" shaped logistic function over the full life cycle of the variable. The number of high school graduates per year, for example, is asymptotically approaching the number of eighteen year olds in the population each year. Since the number of eighteen year olds is tending to decrease with time, due to birth control, the total number of high school graduates is asymptotically approaching a fixed or decreasing value as indicated in Figure A-1. The life cycle for high school graduate education, which would be represented by the logic function, extends over several hundred years and contains numerous cyclic perturbations. The equivalent of high schools (prep schools) originated before the founding of the United States and to date only 70 percent of the eighteen through twenty-one year old population obtains a high school education, Ref. 3, page 19. The appropriate section of the logistic function with cyclic perturbations can be approximated over the time period of this study by simpler functions, such as the exponential function as is shown.

This is possible since many functions such as the gross national product have a life cycle equal to the life of the nation, and the historic trend curve is as shown in Figure A-2. Short term product developments for items such as crystal or vacuum tube radios, prop driven or jet aircraft are not considered or plotted. The total numbers of radios, aircraft, and users are considered and the gross indicators of basic
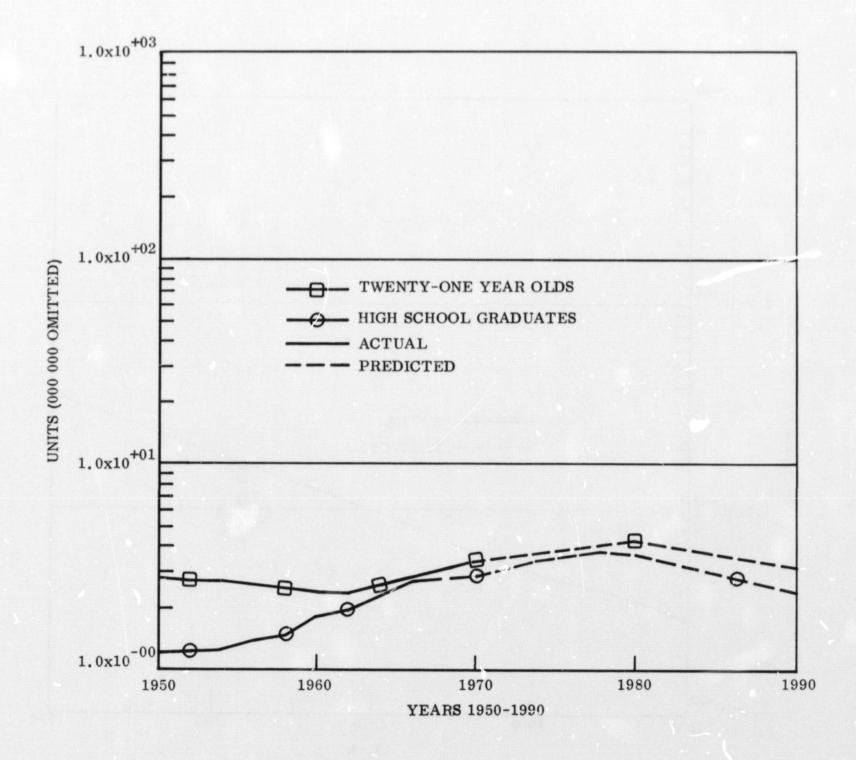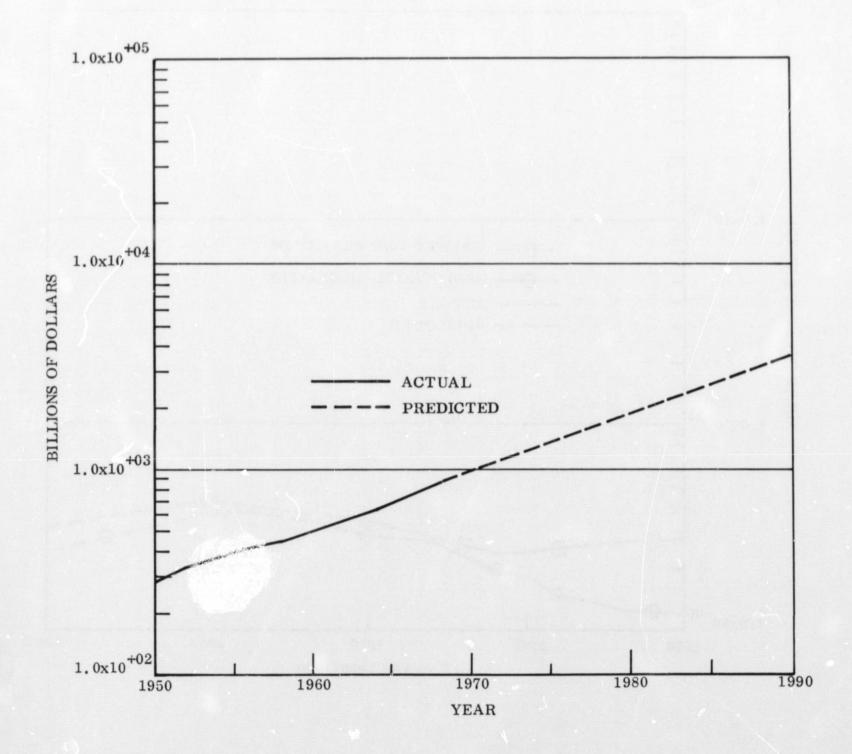
Figure A-1

A-3

Figure A-2

needs usually have long term growth trends. The classic logistic function mathematical model shown below must be modified when used in relation to varying parameters such as dollars, and further lends itself to approximation by an exponential or simpler functions equation (4)

$$Y = \frac{c}{1 + be^{-at}} \tag{4}$$

As total expenditures for education, for example, approach a fixed percentage of the gross national product, the GNP keeps growing and the dollar values which must be expended to maintain services keep increasing due to inflation. Consequently, the functions related to dollars over the forty year period considered by this study are usually asymptotically approaching a value (line) which increases in time at the same rate as the gross national product. The general equation for such a modified logistic model is equation (5)

$$Y = \frac{e^{it} + c}{1 + be^{-at}} \tag{5}$$

A test of this model was applied to a rapidly developing group of services such as the National Space Program, which in a period of ten years countered the Soviet space technology threat. The logistic mathematical model developed for space expenditures since 1957 is:

$$Y = \frac{e^{0.066T + 0.95}}{1 + e^{-1.0t + 3.0}} \tag{6}$$

$$t = year - 1957$$

Figure A-3 presents the curve of this model in comparison with total NASA and Department of Defense expenditures (Ref. 12, page 534) and proposed budgets as reported by Aviation Week & Space Technology, September 22, 1969, page 23. Examination of the plotted curves indicates that the long term trend of the total national space budget appears to be approximately 0.6 percent of the annual gross national product since 1960 — barring unforeseeable threats or radical changes in international conditions. The exponential model for 0.6 percent of the annual gross national product since 1960 is:

$$Y = e^{0.066t + 1.10} \tag{7}$$

$$t = year - 1960$$

Parabolic Trend Analysis

An even simpler model, as described in detail by Beach in Economic Models, is formed by use of the following quadratic function; Ref. 10, page 48 and 57 and Ref. 14, page 6.

$$Y = a + bt + ct^2 \tag{8}$$

This general quadratic form was used by J. R. Hicks to translate Keynes' classical economic model developed in The General Theory of Employment, Interest and Money into mathematical terms. Figure A-4 shows a comparison of a quadratic model of this form to the actual and forecast expenditure for national space programs shown in Figure A-3. The quadratic model equation plotted in Figure A-4 is:

$$Y = 0.1 + 0.416t + 0.0084t^2 \qquad (9)$$

$$t = year - 1958 \qquad (10)$$

The quadratic model is analyzed by Beach, Ref. 10, page 67, as analogous to the physics model of a particle accelerating in a gravitational field where:

$$S = S_o + Vt + 1/2 \, gt^2$$

S_o = the initial distance or value condition

V = the initial velocity condition

g = the steady acceleration constant

The model has an analogy to economic demand and was used for trend analysis. The quadratic model was fitted to three selected data points of each data set by a computer routine. Each set of historical time series data was compared to the quadratic model (referred to as a "parabolic") passing through the data points for the years 1950, 1958, and 1966. The resulting curve provided a convenient reference used in addition to the exponential model for evaluation of the trends and consistency of the time series data and forecasts.

Linear Regression Trend Analysis

The simplest model used for historical trend analysis was the classic economic linear model of the form:

$$Y = a + bt$$

A linear equation was fit to each set of historical data manually and by means of a computerized least squares fit between the model and the data points. The computer program finds the minimum variance between the best linear model approximation and the data points. The resultant linear regression correlates well with data for cases such as: number of aircraft accidents, airmail volume and total student population. The linear model plotted on a regular coordinate chart accentuates the relative non-linearity of data and the effects of short term cyclic variations.
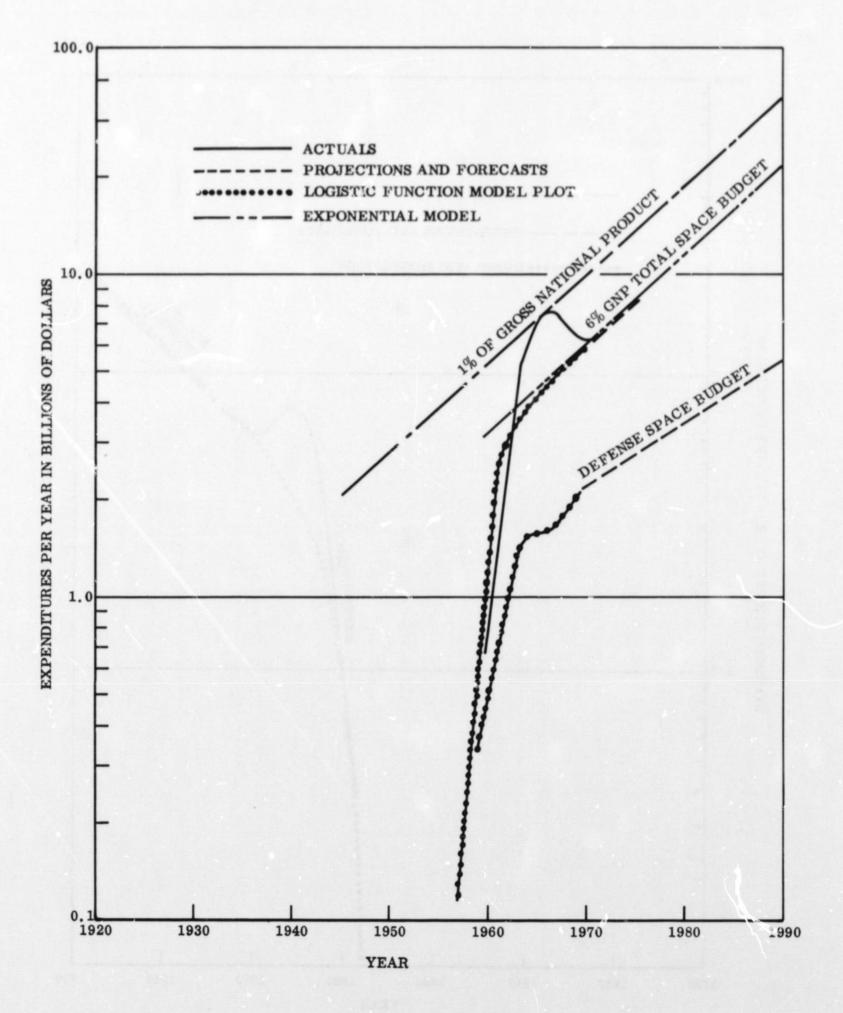
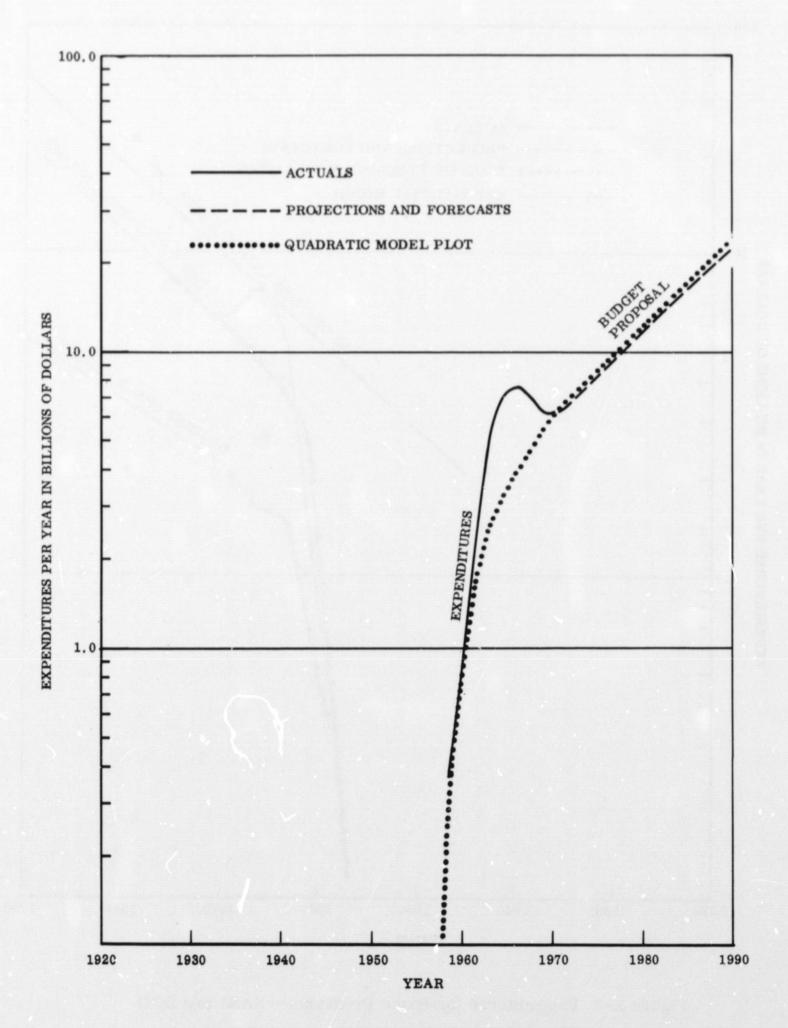Figure A-3 Expenditures for Space Programs — NASA and DOD

A-7

Figure A-4 Quadratic Model of Trend in Total National
Expenditures for Space Programs

APPENDIX B

REGRESSION ANALYSIS

In accordance with contract requirements, a regression analysis was made during the econometric studies of the information transfer requirement study. Such an analysis provides correlation factors between basic economic elements, permitting a prediction to be made on the basis of the correlation. The danger is that correlations which appear high may not be directly interrelated in a linear manner. Pollution, for example, can be closely correlated with population and growth of gross national product. A completely mathematical treatment of limited statistics could project a continued growth of pollution in proportion to growth of population and GNP. Consideration of political and social trends, however, indicate that an increasing portion of the GNP will be utilized to control pollution. Therefore, the historic positive correlation may be changed to a negative correlation in the future. Simple correlation tends to show little or no correlation where strong correlation may exist in reality. Where a linear relationship of the order:

$$Y = ax + c$$

would have a 1.0 (perfect) correlation if plotted a circular relationship:

$$Y^2 = R^2 - X^2$$

would have a zero correlation. Clearly there is a powerful relationship between X and Y in a circle but the trend relationship (slop) is not constant and the correlation is zero. A plot of the two variables with the time sequence of points noted shows the trend and inherent relation between the two variables. Reference 8, Page 153, presents such a relationship between cotton yield per acre, acres harvested, and total yield. Yield per acre has been nearly constant from 1870 until 1925 with constant increases in acres planted to boost production. Since 1925 there has been a steady improvement in yield per acres and a steady decrease in acres planted. The national output of cotton rose steadily from 1870 to 1925 and remained fairly constant from 1925 to 1960. A regression analysis of acres harvested versus yield per acre from 1870 to 1966 would give a low negative correlation coefficient. Correlation analysis from 1870 to 1925 would give a zero correlation because there was essentially no change in yield per acre. Correlation analysis from 1950 to 1960 would give a high negative correlation between acres planted and yield per acre but the historical relationship will be wrong for the authoritative 1960 to year 2000 trend forecasts.

The time sequence plot from 1950 to 1960 indicates a change in trend relation. The plotting of two variables can show a trend or a relationship where the computer mathematical routine indicates that there is no significant relationship. If a strong correlation is shown to exist by regression analysis and plotting of the variables, the established relationship between the two variables may be transitory and of no significance in itself without further substantiation. For regression analysis to be of real value a rational basis must exist for believing that the two variables are related or acting together. Multivariant correlation analysis compounds the problems presented by simple correlation analysis and was not used for this study. Multivariable models were established for specific demands to show the interrelationships between demand for information transfer and economic variables such as population and gross national product.

Klein, Ref. 8, page 196, constructed a sixteen-equation model of the United States. He found that he could not specify his model completely on the basis of economic theory alone and therefore used trial regression to let the historical data suggest relationships

that might be used. This technique is dangerous because it merely searches for regularities in the available data which may not hold true in the future as pointed out above. As pointed out by Beach, this was the fatal weakness of the Harvard indexes of business activity. Klein's work brings to light the inadequacy of present economic theory in attempting to model and predict the economy. Klein's model was improved by Marshall and then by Christ. The equations were fitted to reworked data for the years 1921-1947 and various tests made. One series of tests used "naive" models analogous to the exponential model and the exponential smoothing model to predict 1948 values in competition with the sixteen equation model. For 1948, each of the naive models predicted endogenous variables better, with smaller errors, than did the equations. The problem with exact mathematical models is that they dismiss sociological, legal, political and other factors which play a major role in determining needs and prices, Ref. 8, page 201.

Methodology for Regression Analysis

Correlation coefficients between twenty different variables were obtained by use of computer program BMD 03R, MULTIPLE REGRESSION WITH CASE COMBINATIONS. The program is documented and described in Biomedical Computer Programs, edited by W. J. Dixon and published by the University of California Press.

The program provides both simple and multiple regression correlation coefficients. Multiple regression correlation coefficients were not used for the reasons presented in Ref. 8, page 196. Twenty variables were tested for correlation. In order to test the correlation results two of the variables used were number of the year corresponding to data points and murder rate. The twenty variables were:

- Year
- U. S. Trunk Airline Revenues
- Telephone Toll Revenues
- Interstate Equivalent Voice Telephone Circuits (total)
- Interstate Telephone Circuits for Machine Data and TV
- Total Student Population
- College Graduates per year
- Public Education Expenditures
- Twenty-one year old population
- Total Population

- Hospital Admissions
- Crime Rate
- Murder Rate
- Police Expenditures
- Pieces of Mail
- Publishing Expenditures
- Research & Development Expenditures
- Computer Sales Revenues
- Kilowatt Hours of Electrical Production
- Gross National Product

Twenty-three data points were used for each variable. Historical data were used for each year from 1950 to 1968. Estimated data were used for the years 1969 and 1970. Forecasts of data were used for two years; 1975 and 1980. The reason for including forecast was to test the forecasts and determine correlation with forecast data which induced data dispersion and tended to reduce the correlation coefficients.

Results and Conclusions of Regression Analysis

Table B-1 presents the significant correlation coefficients between the twenty variables. Where the year correlates very closely with a variable, it indicates that the variable is growing at a fairly linear rate with time for the given period. All of the variables tested have correlation coefficients between +0.99 and +0.70 except

murder rate, which has correlation coefficients between +0.22 to +0.24 with the other variables. All of the variables tested except murder rate per 1000 of population have a close correlation with one another. Variables which are growing at related rates due to common or related forcing functions show strong correlation. The results of the regression analysis provide a guide in forecasting and predicting values for variables that can be related to authoritative forecasts for population, education, gross national product and kilowatt hour production. Trend forecasting can be further aided by the use of plotted curves of variables which show trend relations with time. There is no doubt as to the consistency of the trend relationship, when the correlation coefficient is 0.99 as is shown for a larger number of cases.

Table B-1

SIMPLE REGRESSION CORRELATION COEFFICIENTS

1. Year with Population   0.9985

2. Telephone toll revenues with:

KWH	0.998
R&D	0.994
GNP	0.993
Computer Sales	0.987
Population	0.904

3. Interstate Tel Circuits Total with:

Airline Revenues	0.969
Pub Ed Expenditure	0.936
Computer Sales	0.936
GNP	0.888
Population	0.711

4. Interstate Tel Circuits for Machine Data:

Total circuits	0.999
Airline Revenues	0.969
Pub Education Exp	0.929
Computer Sales	0.926
GNP	0.870
Population	0.682

5. Computer Sales:

Pub. Ed. Exp.	0.989
Tel. Tol. Rev.	0.987
KWH	0.983
GNP	0.975
R&D	0.970
Interstate Tel. Cir.	0.936
Year	0.858

6. U. S. Trunk Airline Rev. with:

Pub Ed. Expend.	0.991
GNP	0.969
College Graduates	0.919
21 year olds	0.899
Population	0.844

7. Police Expenditures with:

KWH	0.999
GNP	0.996
Crime Rate	0.995
Population	0.917
Murder Rate	0.10

8. Crime Rate with:

KWH	0.995
GNP	0.988
Education	0.98
Population	0.885

9. Students with:

Population	0.997
GNP	0.924
R&D	0.908

10. College Graduates with:

GNP	0.985
Population	0.977
Ed Expenditures	0.959
Computer Sales	0.929
21-year olds	0.832

11. Public Education Exp:

GNP	0.992
Computer Sales	0.989
Population	0.987
College Graduates	0.959
21-year olds	0.901

12. Pieces of Mail:

Publishing	0.999
GNP	0.985
Population	0.984
Students	0.974
R&D	0.973

13. Publishing with:

Mail	0.999
GNP	0.989
Population	0.979
Students	0.966

14. R&D with:

KWH	0.996
GNP	0.993
Population	0.929
Students	0.908

15. Hospital Admissions with:

GNP	0.998
College Graduates	0.986
Pub. Ed. Exp.	0.985
Population	0.949
21-year olds	0.876

16. GNP with:

KWH	0.995
Tel. Rev.	0.993
R&D	0.993
Pub Ed Exp	0.992
College Grads	0.985
Year	0.947
Population	0.943
Students	0.924

17. KWH with:

R&D	0.996
GNP	0.995
Year	0.921
Population	0.917